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OFFICIAL PUBLICATION OF
THE AMERICAN ASSOCIATION OF ORTHODONTISTS,
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THE AMERICAN BOARD OF ORTHODONTICS

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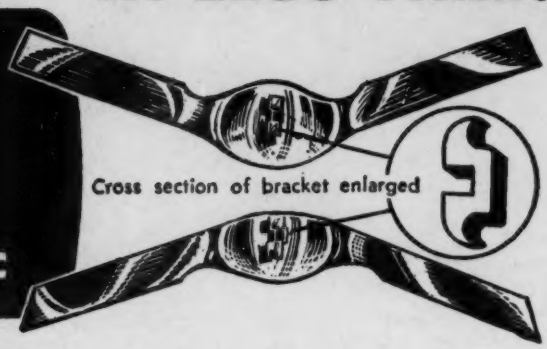
Vol. 42 **APRIL, 1956** **No. 4**

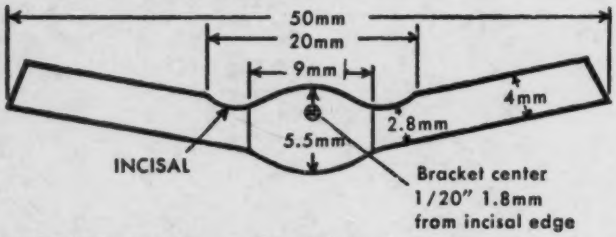
NEW! for easier adaptation and better fit — IN LESS TIME!

Whitman
CUSPID and BICUSPID BANDS FOR "EDGEWISE" TECHNIC

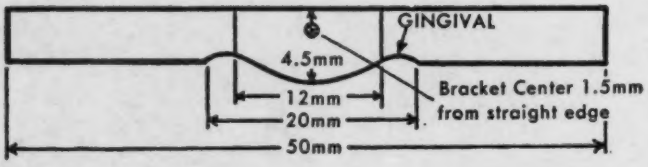


- Designed to eliminate necessity of festooning interproximal edges.
- Practically self-fitting, — contoured and designed for "Edgewise" technic.
- Shaped to bend parallel to the cut.
- Eliminates problem of "dog ears" on cuspids.

CUSPID BAND — .004 thick



BICUSPID BAND — .004 thick



WHITMAN BANDS ARE PRECIOUS METAL BANDS

fabricated from a highly tarnish-resistant alloy of exceptional working qualities. Hydrogen annealed for easy adaptation, the metal takes on exceptional edge strength when work hardened. Available with or without 1/20 length "Edgewise" brackets offset for easier alignment of bracket centers. Packages of 10 or 100.

Whitman 3-in-1 combination instrument

new!

For "edgewise" technic,—Gauge insures uniform alignment of brackets, seater insures accuracy of band heights, burnisher is adaptable to all conformations. Write for Whitman Band and Instrument folder.

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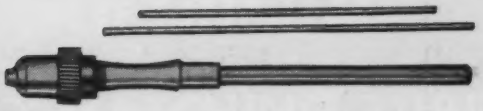

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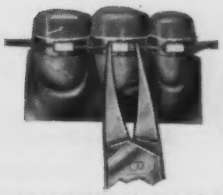
BAKER GENUINE JOHNSON LOCKS AND BANDS IN PRECIOUS METAL OR STAINLESS STEEL . . .

LOCK PLACING PLIERS

IMPROVED JOHNSON LOCK

JOHNSON VISE



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Dr. Johnson restricted the manufacture of Johnson Twin Arch Locks to one company only—to assure that Johnson Locks and parts purchased in any part of the world, be interchangeable and of uniform quality. For this reason, it is advantageous to accept only Baker-Made Genuine Johnson materials.

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Per dozen	$9.60
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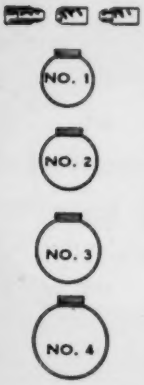
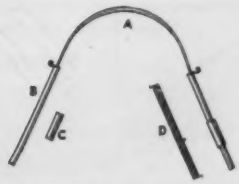
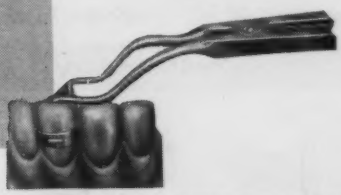
All genuine Johnson Materials, including Instruments, Laminated Arch End Tubing, Flat Coils of Steel Arch Wire without side bends, are available.



ANTERIOR PINCH BANDS



STAINLESS STEEL TWIN WIRE ARCH WITH .023 I. D. .035 O. D. END TUBES ORALIUM MOLAR TUBES ¼" X .036 SPRING STEEL COIL, .009 WIRE



ANTERIOR BAND FORMING PLIERS

LOOP MOLAR BANDS

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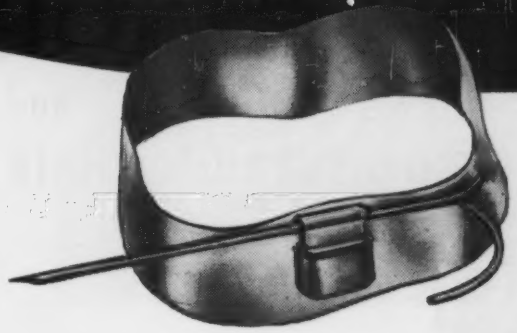
BETTA SPLIT LINGUAL

PAT. PEND.

SHAFTS AND MATCHING TUBES



Made of SARDA CHROME to be used with Stainless Steel or Precious Metal Arch Wires

- EASY TO USE
- LESS BREAKAGE

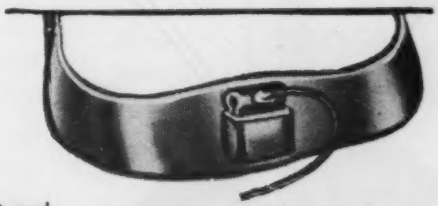
Conform Arch wire to model

Slide Betta Split Shaft over ends of arch wire

Position into Tubes soldered to Molar Bands

Then lift shafts half way out of tubes and solder shafts to arch wire

...as a horizontal tube with vertical insertion



Solder Lokwire to top of Shaft

Insert and Lock Shaft into Tube

Archwire will slide freely into horizontal Tube-like Portion of the Shaft

Betta Split Lingual Shafts and Matched Tubes

Sizes: .036 .040 ....**3.95** per dozen **35.00** per gross

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for cephalometric studies

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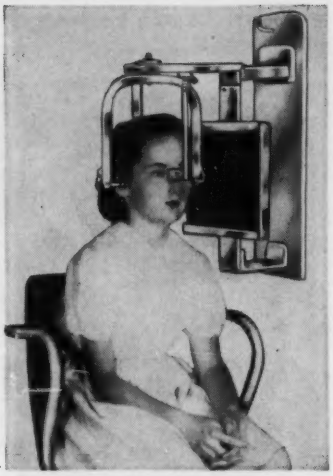

The Weingart Cephalometer, a compact head-positioning unit, permits accurate duplication of profile radiographs of the skull for diagnostic and cephalometric studies. In addition, this versatile unit can be used for antero-posterior, temporo-mandibular joint and lateral jaw x-rays. A wall mounted stabilizer, also available, is a valuable complement to the Cephalometer; it precisely positions the head of the x-ray tube.

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The chair comfortably seats adults as well as children. It is precision built, chrome finished and upholstered in leather-covered foam rubber in a choice of standard dental colors.

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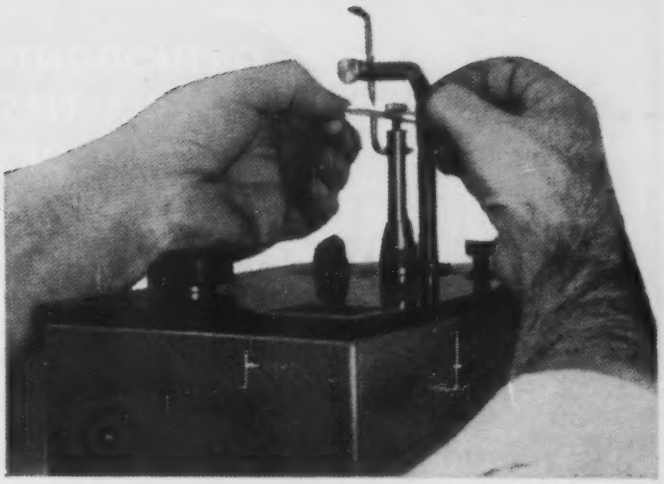

WRIST ACTION BUTTON — Simplifies the positioning of wires, brackets and band materials between the electrodes by leaving the hands completely free to properly place the materials and giving an unobstructed view of the work. The ball bearing internal lever system connecting the wrist action button with the electrode holder is engineered to give the proper pressure for all gauges of Orthodontic Material.

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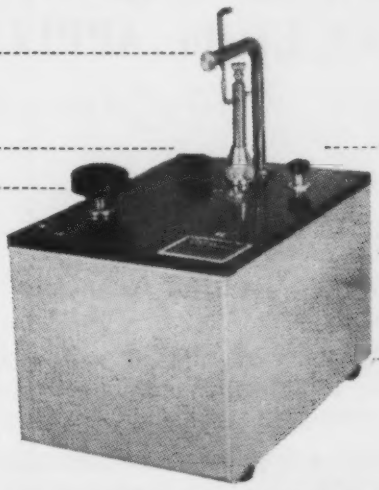

Model No. BO3-A **$59.50**

With the **TRIGGERMATIC SWITCH**

PAT. PENDING

In addition to the momentary welding switch. The Triggermatic switch, automatically controls a single pulse of current. Eliminates all possibilities of burning

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First in Modern Orthodontic Technique

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IN FLAT WIRE

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This is a new specialty recently added to
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- **ORTHODONTIC APPLIANCES**
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- **WHITMAN Elastic APPLIANCES**

All of these appliances reflect our use of the most technically advanced methods and ideas.

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THIS IS YOUR LABORATORY . . .

- for extremely careful execution of that special idea or design
- for really custom-made appliances that are made to fit with minimum of time and effort on your part

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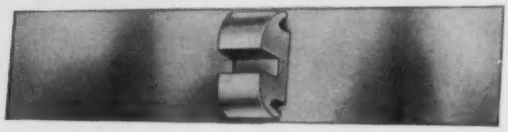
——WITHOUT——
——FLANGES——
WELDED TO CHROMEX BAND MATERIAL



This flangeless innovation in bracket design will permit the Orthodontist to form a tru-fit band that will follow the anatomical contour of the teeth—an accomplishment not possible with the flanged brackets.

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(Sizes: 125 × 003; 125 × 004; 150 × 003; 150 × 004; 100 × 004)

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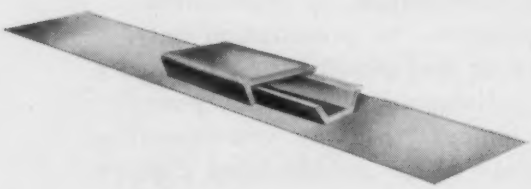

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BRACKETS and CAPS
WELDED TO CHROMEX BAND MATERIAL

Precision-made, finest quality material and smoothly polished as are all Chromex Brackets.

Twin-Arch Brackets Welded to Band Material_____**$3.60 Doz. . . $39.50 Gross**
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Intermaxillary Hooks .030; .036; .040
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End Sections With Hooks 0.36; .040
$2.80 Doz. _____$30.75 Gross

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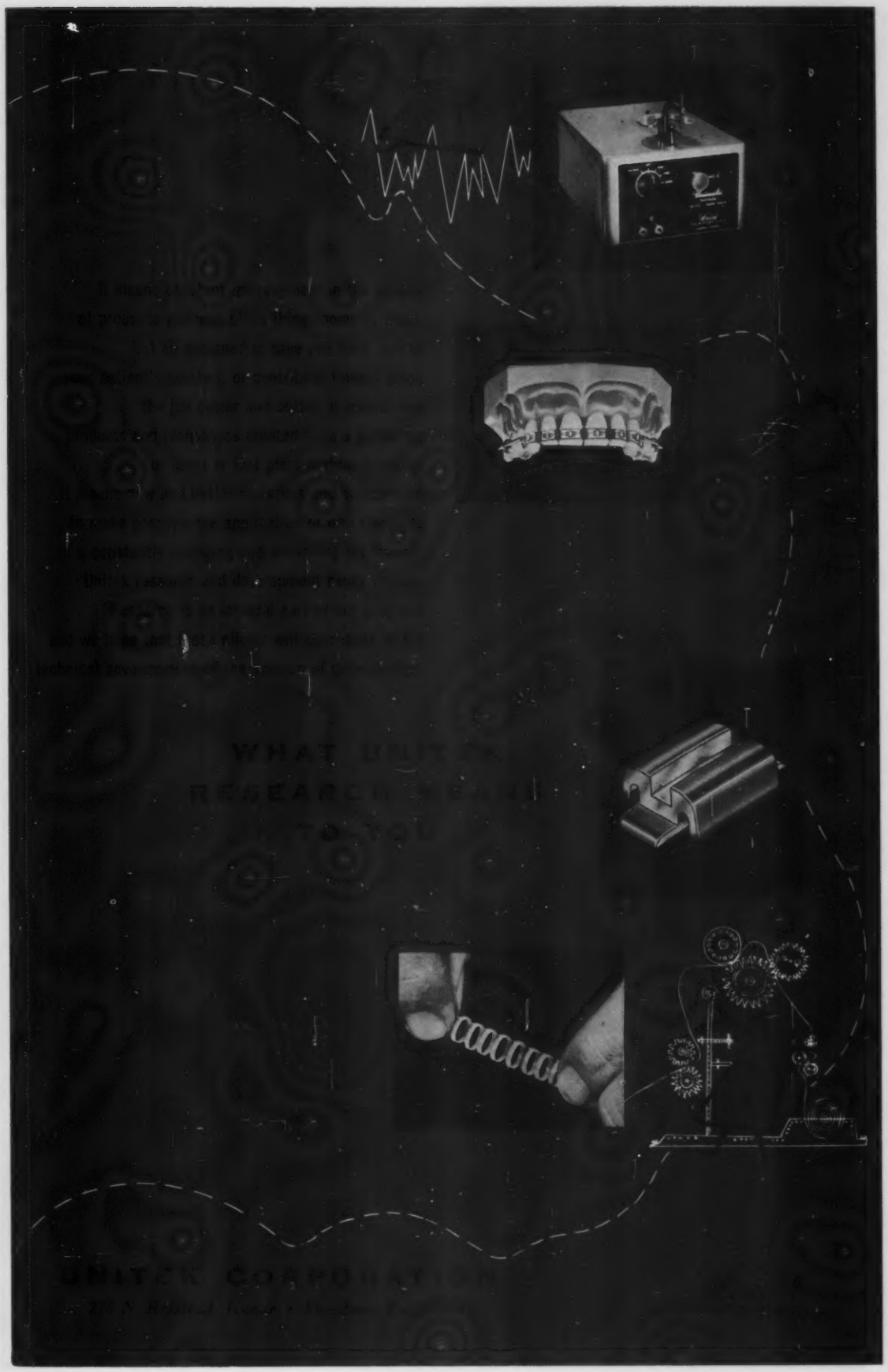

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A Stable Hydraulic Positioner for Cephalometric Radiography

$115.00
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Precision positioning between seat levels of 23 in. to 42 in. Patient is raised and lowered hydraulically by foot controls. Positive control within 1/100 in.

Compact and sturdy, the Hydr O Seat occupies only 1 square foot of floor area. It is engineered to meet your requirements of performance and utility.

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Bubble free plaster in 15 seconds.

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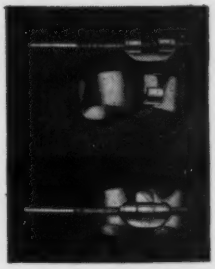

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Makes removal and reinsertion of either lingual or labial arch extremely simple. Permits exact and rapid lengthening or shortening of arch — 1/100 inch per revolution of swivel—without disengaging it from bands on anterior teeth. Allows arch to lie in a straight line at the gingival margins, doing away with vertical bends.

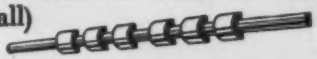
TUBES AND SHAFTING

TUBES — HALF ROUND

DL-8, length .08″; DL-10, length .10″ (Inside dimensions .032″ x .064″; .012″ wall)

DL-10H, length .10″ (Inside dimensions .032″ x .064″; .014 wall, extra heavy)

DS-8, length .08″; DS-10, length .10″ (Inside dimensions .020″ x .040″; .010″ wall)



SHAFTING — HALF ROUND

NEY-ORO ELASTIC #4, special shape to fit DL and DS tubes. PALINEY #7, special shape to fit DL and DS tubes. 3 inches of shafting to 1 dozen tubes is usual proportion.

WIRE SIZES

- Round Arch Wires
  .032″ .036″ .038″ .040″
- Auxilary Springs
  .020″ .022″ .025″
- Ribbon Arch Wires
  .022″ x .028″ .022″ x .036″
- Rectangular Arch Wires
  .022″ x .025″ .022″ x .028″ .022″ x .036″
- Square Arch Wires
  .022″ x .022″ .024″ x .024″

5 dwt. container of solder in wire form. 26 ga. and 28 ga.

SOLDER SHAPES

- Band Solder, .809 fine
  Each piece .20″ x .062 x .0075″.
- Attachment Solder, .560 fine
  Each piece .127″ x .062″ x .0075″.
- Solder Ferrules, .560 fine
  Each piece .032″ inside diam. x .003″ wall.
- Solder Disks, .560 fine.

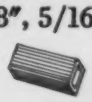
ROUND TUBES

R-025, length .25″, fits .040 wire
R-125, length .25″, fits .036 wire
R-135, length .35″, fits .036 wire
R-145, length .45″, fits .036 wire
R-220, length .20″, fits .030 wire
R-310, length .10″, fits .025 wire

Wall thickness of all around tubes is .012″.

RECTANGULAR TUBES

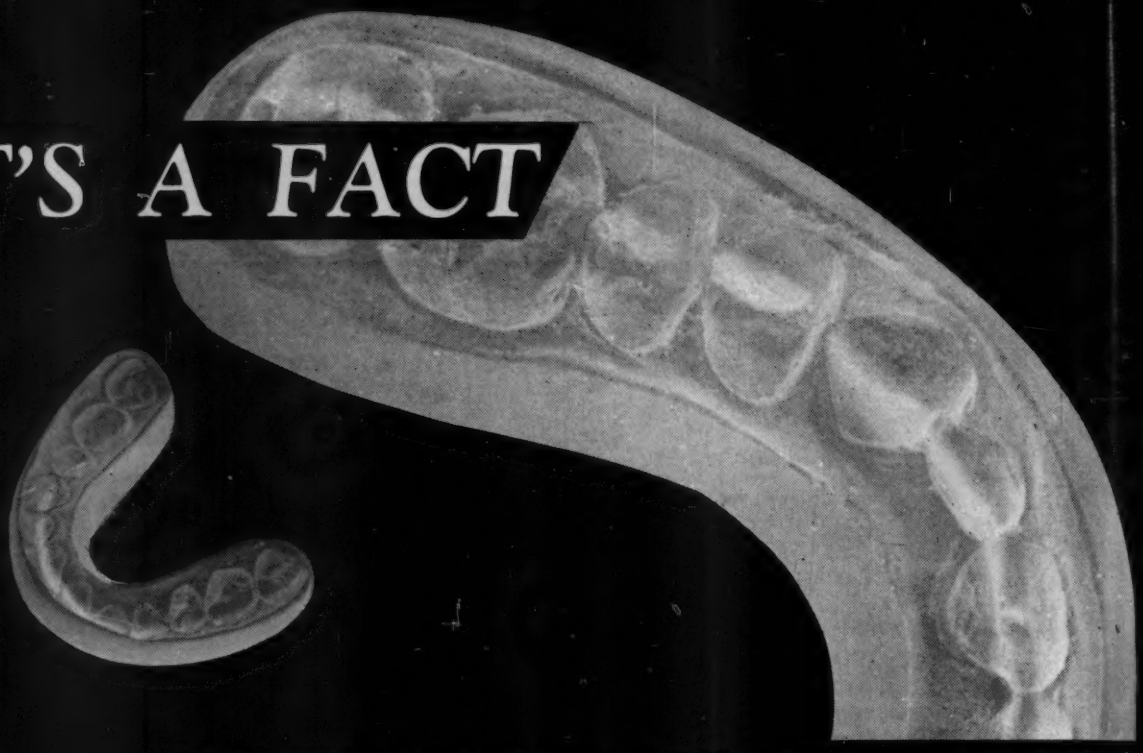
.022″ x .028″, 5/16″ long



THE J. M. NEY COMPANY Gold SINCE 1812

HARTFORD CONN.

IT'S A FACT



The number of orthodontists finishing their cases with Tooth Positioners has more than doubled in the past two years.

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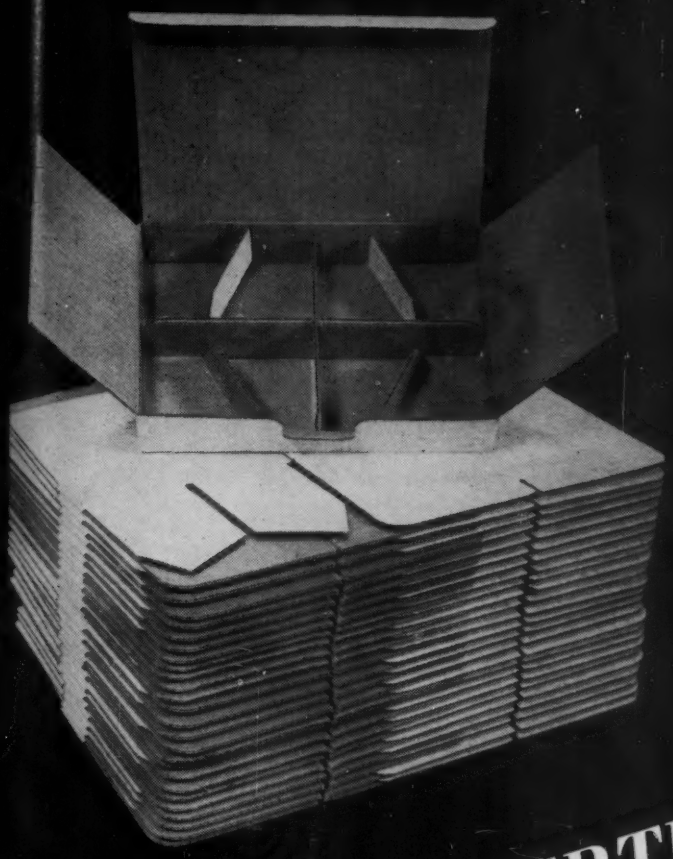

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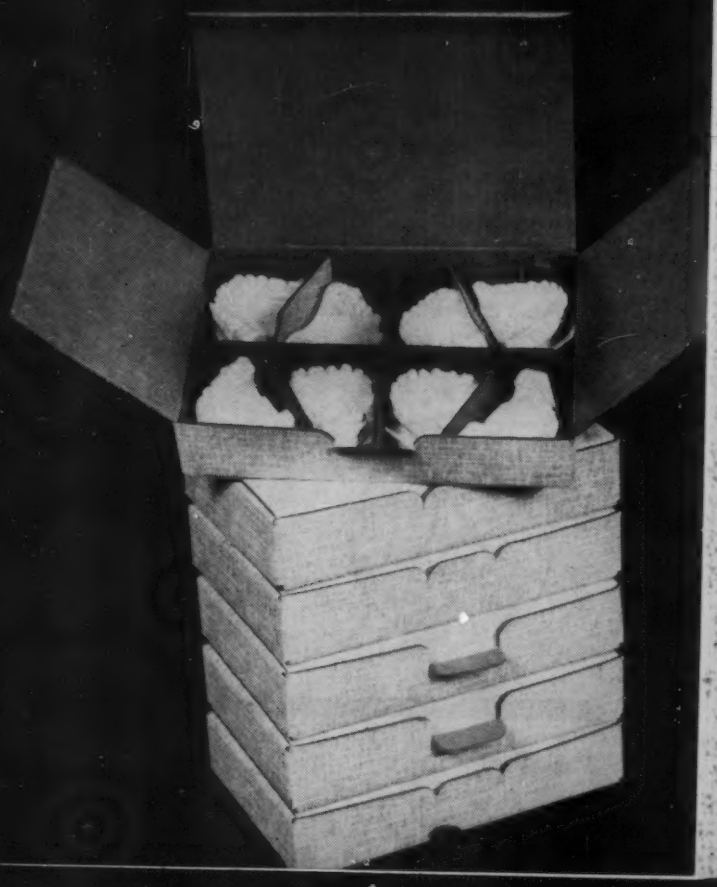

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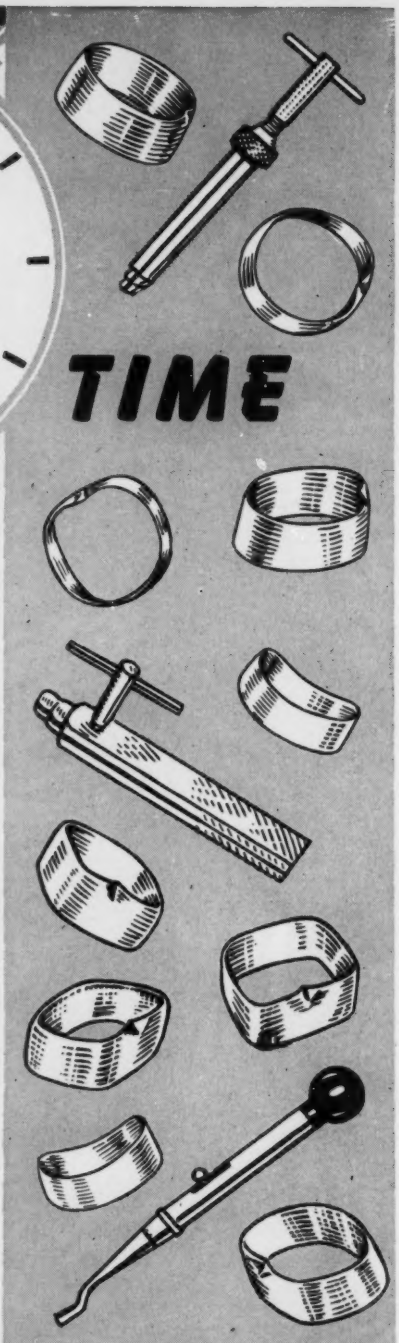

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Original Articles

PRESIDENT'S ADDRESS, GREAT LAKES SOCIETY OF ORTHODONTISTS

CARL R. ANDERSON, D.D.S., GRAND RAPIDS, MICH.

ON BEHALF of the Columbus membership of the Great Lakes Society of Orthodontists and myself, I cordially welcome you to the twenty-sixth annual session of our Society. This is the first time that our Society has had the pleasure of meeting in Ohio's capital. All of us who were fortunate enough to attend the 1948 national meeting here well remember the spirit of hospitality and good fellowship which prevailed at that time. That same spirit still exists in Columbus and I know that we shall have an enjoyable stay here and will look forward to returning soon. I am only sorry that Dr. Robert Wade could not reside in his own home town, but Providence has dictated otherwise.

We are greatly indebted to Dr. Edwin Flint, our Program Chairman, who has worked diligently this past year assembling the scientific sessions which you will hear in these next few days. I know that you will agree with me at the close of this meeting that he has produced a scientific session for us which measures up well with those of the past, and for which our Society is noted. To Drs. Fred Aldrich and Robert Wade, the coordinators and chairmen of local arrangements, I express my sincere appreciation for their unceasing efforts and careful planning of the myriad details that were entailed for this meeting. One year ago, when I assumed the presidency of the organization, I had ample assurance from the many men of Columbus that, although I was in Grand Rapids and unable to do much in the way of local arrangements, I would have little to

Presented at the annual meeting of the Great Lakes Society of Orthodontists, Columbus, Ohio, Oct. 31, 1955.

worry about, as everything would be willingly taken care of by the Columbus membership. The response of these committee members will long be a treasured remembrance of the true meaning of the word "cooperation." To our able and hard-working secretary, Hunter Miller, and treasurer, George Harris, we all owe our gratitude for their excellent services to our organization during this past year. They have given unstintingly of their busy hours so that we might have another excellent year in the Society. To Mrs. Fred Aldrich and Mrs. Robert Wade, the cochairmen for the ladies' activities, Mrs. Anderson and I wish to express our thanks for all they have done to make the ladies' visit to Columbus an experience long to be remembered. To all who have assisted in this meeting, I can only say most sincerely "thank you, one and all."

According to our Constitution and By-Laws, the president is to deliver an annual address before this Society with the idea of offering suggestions based upon his year's experience in the office—ideas which will be for the improvement of the organization. Following this address, a committee is appointed by the vice-president to review the president's address and report at the next day's business session. This we have done annually. However, I have felt at times that the committee report has become a rather time-worn and unproductive process which is rapidly being dispensed with in most organizations. I am suggesting that this procedure be changed and that the president's address be read to the executive session on Sunday so that any action deemed necessary might be taken at the business session following the reading of the address before the membership. I think we will accomplish two things by this: first, a saving of a certain amount of time in our busy program by eliminating a committee and its report and, second, more direct action on any recommendations made in the address.

At the present time the Executive Committee is empowered to fill any vacancies created in any of the offices of our organization in the course of the year. However, I believe that it is customary in practically all organizations for the vice-president to assume the office of the president in the event of his death, resignation, or removal. This is the procedure which exists in our parent body, the American Association of Orthodontists, and I believe it would be well for us to consider the same procedure. To assure the Society of having a vice-president familiar with the proceedings of the organization, we might consider going one step further and placing the chairman of the Censorship Committee into the vice-presidency following his term of office as program chairman and one year preceding his elevation to the office of president-elect. This, I believe, would result in ample assurance to the membership that there would always be in office a vice-president who is familiar with the problems and proceedings of the organization.

In his president's address of two years ago, Dr. Scott Holmes recommended the formation of a committee to study and develop a better procedure for the referral of transfer cases. This recommendation was carried to the American Association of Orthodontists with the result that past-president Frederick West of the American Association has appointed a committee for the parent body with our Dr. Scott Holmes as chairman. During this past year I have appointed Dr.

Vernon Fisk of our Society as chairman of a similar committee to work with Dr. West's committee. It is my hope that Dr. Fisk will be reappointed by your next president.

I believe that we should all pay our respects by giving special recognition to those members of our organization who have returned to their practices during this past year after serving in the Armed Forces. Many of us do not fully appreciate the hardship, dislocation, and financial loss encountered by one called to duty after establishing a practice. To all these who have answered this call, I wish to say, "Well done. You have served your country honorably and well. We are proud of you."

At the San Francisco meeting in May, the fact was mentioned that a women's auxiliary to the American Association of Orthodontists is contemplated. It might be well for the members of our organization to encourage their wives to consider the establishment of an auxiliary unit so that the women might have an organization of their own which would be duly organized and, as such, would have two advantages: (1) as a duly organized auxiliary, certain advantages would be apparent in the way of tax deductions and (2) with their own treasury, they would be independent of any subsidy from the Great Lakes Society for their activities.

I wish to thank the membership, and especially the Executive Committee, for the honor they paid me by electing me to the office of president-elect a year ago this past spring at the time Dr. Wade assumed office. It has been a pleasure and a privilege to serve this Society, both as secretary-treasurer and now as president. It is an honor of which I shall always be most proud.

A COMPARISON OF VARIOUS SURVEYS ON THE ADEQUACY OF BASAL BONE

C. EDWARD MARTINEK, D.D.S., DETROIT, MICH.

ONE of the first treatment decisions that an orthodontist must make is whether his patient can be helped by removal of teeth as a part of the therapeutic program.

Anomalies that are definitely extreme on either side of the decision are not difficult to solve, but the middle ground is frustrating. To help ease this frustration, certain studies have come forth from alert members of our profession. These studies attempt to analyze the problem on a mathematical basis while tempering conclusions according to biologic factors. It must be admitted that the recommendations have left the matter eased, but not solved. Thus, this article may be clarifying in a very small measure, but disappointing in the larger sense.

Nance,[1] Carey,[2] and Ballard and Wylie[3] have suggested methods for analyzing the mixed dentition to predict whether there would be adequate accommodation for all the adult teeth. Many conditions, such as parallax, and the uncertainty of growth modify their prognostications. As a result, these methods have not gained the degree of popularity they deserved.

In spite of their limitations, the various mixed dentition analyses have been very helpful. Certainly they have given tremendous stimulation to our current preoccupation with interceptive and palliative orthodontics.

Many analyses on the adult dentition likewise have appeared in the literature to appraise the adequacy of supporting bone. Among them are the papers of Strayer,[9] Howes,[4] Rees,[5] and Kesling,[6] and it is with these that the present treatise is chiefly concerned.

From the standpoint of clear clinical interest, I found myself wondering how conclusions of those analyses would compare with one another if applied to the same treatment problems. As a result of that interest, the next five patients starting with me were reviewed in the above manner. The comparison proves nothing, although it may be of some significance.

All the analyses of the adult dentition, with which this article is concerned, draw a quantitative relationship between the amount of tooth material and the amount of basal bone present to support those teeth. In general, the four surveys are in agreement on their concepts of the so-called "apical base," but their methods of comparing it with the tooth material differ.

Presented at the annual meeting of the Great Lakes Society of Orthodontists, Neil House, Columbus, Ohio, Oct. 31, 1955.

The report of Howes,[4] published in the August, 1947, issue of the AMERICAN JOURNAL OF ORTHODONTICS AND ORAL SURGERY, deals with the maxillary apical base only. He defines it as "that part of the body of the maxillae from which the maxillary alveolar process has developed." His reason, with adequate reservations, for concentrating on the apical base of the maxillae is that it seemed to be a greater factor in the production of malocclusion. He says, "The maxillary dental arch, occluding as it does outside the mandibular dental arch, and being fixed to the skull, holds the whip hand over the mandibular arch and governs its lateral development."

At the start of his study, Howes measured fourteen normal dentures, relating the combined widths at contact points of all teeth anterior to second molars to the distance across the dental arch from first premolars just inside their buccal cusps. This ratio proved to be 43 per cent.

Next, he became interested in comparing the arch width at first premolars with a caliper measurement taken directly in the mouth above the apices of the maxillary first premolars, which he calls the canine fossa or the C. F. measurement. In 200 cases in which he made the canine fossa (C. F.) measurement, he found a variation of 19 mm. between the largest and smallest C. F. measurement. He also found that the C. F. never was smaller than the arch width at the first premolars. He interpreted a canine fossa measurement greater than that of the first premolar measurement as being the amount of expansion possibilities, and felt that no expansion could be expected to retain if it exceeded the canine fossa measurement. He also observed that distal movement of first premolars would increase the C. F. measurement.

The analysis which Howes developed from his studies was a percentage relationship between the combined widths of the maxillary teeth anterior to the second permanent molars and the canine fossa width. This creates a fraction. The fraction would be canine fossa width divided by the combined mesiodistal measurements at the contact points of all teeth anterior to second permanent molars. Thus, if the canine fossa measurement was 41.2 mm. and the tooth material was 91.8 mm., the relation of the former to the latter would be 44 per cent. This means that the tooth material equals 44 per cent of the canine fossa measurement.

On 125 cases he had treated, Howes made this analysis and found that fifty-two of the cases involved no extractions and had a C. F. to M. T. M. (maxillary tooth material) ratio of 44 per cent plus. This we will call Group I. Group II consisted of fifty-three cases, of which three involved extractions, and the C. F. to M. T. M. measurement was 37 per cent to 44 per cent. The remaining twenty cases in Group III had a C. F. to M. T. M. ratio of 37 per cent or under. Nineteen of the cases in Group III involved extractions. The conclusions made were:

1. If the ratio of canine fossa (C. F.) to the combined widths of maxillary first molars, premolars, canines, and incisors (M. T. M.) is 44 per cent, it may be assumed that the apical base is adequate.

2. If the ratio between C. F. and M. T. M. is between 37 per cent and 44 per cent, the adequacy of basal bone is questionable. In such cases, Howes suggests, it may be wise not to treat at all, or to accept residual irregularity of the lower anterior teeth following treatment.
3. Extractions are definitely indicated, he believes, if C. F. to M. T. M. is 37 per cent or less.

The second analysis with which we are to be concerned is that by Rees,[5] which appeared in the AMERICAN JOURNAL OF ORTHODONTICS in September, 1953. The title of his article was "A Method for Assessing the Proportional Relation of Apical Bases and Contact Diameters of the Teeth." Here, again, apical base is described as that portion which supports the alveolar process. A principal difference is that Rees involves the mandible and its teeth as well as the maxillae.

The philosophy underlying his approach is stated as follows: "Growth of the apical base of both jaws subsequent to the eruption of the first permanent molar is confined to the distal portions to be occupied by the second and third molars. Vertical height increases in the alveolar process until full eruption of the teeth. Apical base from first molar to first molar does not appear to change subsequent to the eruption of these teeth, except to decrease the equivalent of the amount of forward migration during transition from mixed to permanent dentition (Nance)."

The analysis compares the upper base with the upper teeth, the lower base with the lower teeth, the upper base with the lower base, and the upper teeth with the lower teeth.

The symbols used may be a little bit confusing but, actually, they are quite clear: U. B. for upper base, U. T. for upper teeth, L. B. for lower base, and L. T. for lower teeth. All the measurements are made on orthodontic casts, after all muscle attachments and the frenum are trimmed flush with the basal area. The measurement of basal bone is made from an area 8 to 10 mm. from the gingival margin. Tooth material is judged by measuring all teeth anterior to first molars at their contact points.

To establish the apical base measurement, Rees places a ruler against the side of the cast at right angles to the occlusal surface and draws a line at the mesial contact point of each permanent first molar and a third line through the midline contact of the central incisors. The line is extended to a point 8 to 10 mm. from the gingival margin in an apical direction. A thin strip of tape is attached to the cast so that each terminal end is at the molar marks passing through the incisor point. This strip of tape is removed from the cast and placed on a line of a ruled card. This represents the length of the apical base, which is then measured for comparison with the combined widths of all teeth anterior to the first molars.

Using the method just described, Rees studied the casts of twenty normal cases to see if there was any constancy in ratio between the base and tooth

material. He found that the upper base measurement was greater than the upper teeth measurement by 1.5 to 5 mm. and that the lower base measurement was greater than the lower teeth measurement by 2 to 7 mm. He felt that this range in average normals could be used as a basis for judging whether treatment problems would involve reduction of tooth material.

Rees also found that dimensions of upper teeth exceeded those of lower teeth by 5 to 10 mm. and that the upper base was normally 3 to 9.5 mm. larger than the lower base.

The application of this analysis for diagnostic purposes stresses the fact that, if a discrepancy exists, the amount of the discrepancy is an important factor. Thus, if the upper base was 2 mm. less than the minimum requirement between it and the upper teeth, it would not be indicated that the upper teeth be reduced 14 mm. through extraction of two premolars. On the other hand, if the relation of the upper base to the upper teeth were 10 mm. less than the minimum requirement, extractions would be indicated. Determination of extractions for the lower jaw would likewise be judged according to the amount of discrepancy that exists between the lower base and the lower teeth.

While the repositioning of teeth on duplicate casts had been suggested by others, it remained for Kesling[6] to popularize the so-called "diagnostic set-up." It has been described by some as being one of the most reliable guides for determining the need of reducing tooth material.

The pattern for repositioning of the teeth on dental casts is made from a lateral cephalogram.[7] On the cephalogram one draws the Frankfort plane and records the position of the root apex of the mandibular incisor by a dot. A line is then drawn connecting the apex of the mandibular incisor root with the Frankfort plane to form a Frankfort-incisor angle of 65 degrees. The exact inclination of the mandibular incisor is then drawn and a measurement, in millimeters, is taken from the incisal edge of the incisor to the line which forms the 65-degree angle with the Frankfort plane. This tells the number of millimeters the mandibular incisors must be tipped lingually.

Teeth are sawed from the mandibular duplicate cast with a fine blade and the incisors are waxed back on in accordance with the movement determined by the cephalogram. By waxing the remaining teeth onto the mandibular cast, one is able to detect the amount of room needed to accommodate all the teeth. The maxillary teeth are then sawed from the duplicate cast and set up in wax to occlude with the lower teeth.

Kesling does not resort to removal of teeth if he can compensate inclinations of the mandibular incisors to within 3 degrees of the ideal. He encourages one to range slightly toward a 70-degree angle rather than a 60-degree angle. This is similar to the philosophy of Tweed,[8] who believes that the extraction deadline is reached at 62 degrees. Kesling further points out that Class II treatment usually increases final angulation by about 5 degrees, and that this should be considered in the original calculations.

The final analysis with which we are dealing is that by Strayer,[9] published in the AMERICAN JOURNAL OF ORTHODONTICS in October, 1952. His procedure for case evaluation and analysis is likewise an effort to relate apical base with tooth substance.

He assumes an apical base measurement based on the definition of the aforementioned investigators, although his method of determination is somewhat different.

The analysis attempts to provide a visual means for judging whether the apical base is of sufficient dimension to accommodate all the teeth. A drawing is made, reproducing the apical base of each jaw, and then the widths of the teeth are marked on the drawing. The drawing is made on Plexiglas, which is transparent and may be laid on the casts to show what tooth movement is indicated, and the operator may judge whether such tooth movement is possible without removal of teeth. The method is suggestive of the technique used for outlining ideal arch forms in the Bonwell-Hawley diagrams.

Plexiglas used in the analysis is approximately $\frac{1}{16}$ inch thick. It is 3 inches wide and $3\frac{1}{2}$ inches long.

Determination of the apical base dimension is made from the dental casts and drawn in arch form on the Plexiglas. Measurements are obtained by marking the dental casts in the following manner:

1. A mark is placed on the cast at the junction of the apical third and incisal two-thirds of the central incisor root.
2. The anteroposterior of the apical base may now be measured with calipers by placing one point of the calipers at this mark and the other point at the posterior base of the model, keeping the calipers parallel with the midline of the cast. After drawing a scratch mark down the center of the $3\frac{1}{2}$-inch dimension of the Plexiglas, at right angles to the base, this measurement is then transferred to the midline scratch. One point of the compass is placed at the lower border of the Plexiglas and the other on the midline scratch mark and pierced into the Plexiglas.
3. In the upper jaw, width of the apical base is determined by placing a line from the ridge of the mesio-buccal cusp to the junction of the apical third of the root and measured from right to left first molars across the arch with calipers.
4. A similar measurement was made in the lower jaw in the apical third area at a point below the mesio-buccal grooves.

After the apical base outline is drawn on the Plexiglas, scratch marks representing the dimension of each tooth are made on it. By placing the Plexiglas over the model, the exact relationship of tooth material to supporting bone may be easily determined.

Since the exact technique for making the drawings in the Strayer analysis has been recorded previously in the orthodontic literature, I will not repeat

it here. Nevertheless, one would be well repaid in undertaking to study it and would find the analysis to be easy, quite accurate, and highly informative.

Having outlined the various surveys submitted to us by Howes, Rees, Kesling, and Strayer, I should now like to compare the conclusions when all of them are applied to the same cases.

The first case to be considered is that of S. W. Her dental casts show a tooth relationship classified as Class II, Division 1, subdivision right. Her profile was convex and the angle of convexity, according to the Downs analysis was plus 17. Her Frankfort-mandibular plane angle was 30 per cent and lower incisors were plus 11 degrees to the mandibular plane. SNA-SNB difference was 9 degrees, and path of closure indicated a small amount of functional posterior displacement.

On the basis of Howes procedure, the canine fossa (C. F.) measurement was 35 mm. and the maxillary tooth material was 98 mm. This works out to 35.7 per cent and places the case in Group III. While distal movement of the maxillary right buccal segment would increase the canine fossa (C. F.) measurement, it would be too small a gain to place the problem within another group. No expansion possibility exists, because the interarch first premolar width nearly equals the canine fossa (C. F.) measurement. Based on these factors, the case will require extractions.

The Rees analysis would indicate this case to be a borderline extraction case. The upper base is 1 mm. smaller than the upper teeth measurement. This is 2.5 mm., less than the range for normal but not a sufficiently radical variation to place it in the extraction group. Extractions would remove approximately 15 mm. of tooth material where only 2 mm. to 2.5 mm. of room is needed in each arch. A severe space closure problem would likely be confronting the operator. On the other hand, it appears as if facial balance is impossible unless tooth unit reduction is introduced. The upper base related to the lower base is within normal range and upper tooth material to lower tooth material is also close to the normal range, a condition which could exist in a bimaxillary protrusion problem.

Placing the lower anterior teeth at a 65-degree angle with the Frankfort plane, according to the Kesling analysis, would require in this case that they be tipped lingually 10 mm. The diagnostic setup disclosed that a mild space closure problem would be encountered with the lower teeth, but none with the upper teeth. This indicates a need for reduction of dental units.

Placing the Plexiglas recording plates over the occlusal surfaces of the mandibular teeth with the lower border of the plate flush to the posterior surface of the cast base, as used in the Strayer analysis, it is found that the check marks on the Plexiglas indicate that buccal segments would have to be moved posteriorly to the posterior border of the cast. Since the posterior cast base represents the absolute limit of posterior movement of these mandibular teeth, the case becomes a near extraction problem. The recording plex indicates that in the maxillae the teeth on the Class I side fall but slightly distal to the scratch marks on the Plexiglas, while on the Class II side they fall

approximately 3 mm. mesial to the scratch marks on the plexiglas. This reflects the unilateral Class II, Division 1 malocclusion that is present and further indicates that it is a questionable extraction case.

The second case to which we will apply these analyses is that of D. P. Dental casts show a tooth relationship classified as Class II, Division 1. Facial profile was satisfactory when one visualized reduction of the protrusion of maxillary teeth and the Class II tooth relationship. The angle of convexity was well within the normal range of the Downs analysis, it being minus 3 degrees. The Frankfort-mandibular plane angle was 35 degrees, with lower incisors at plus 2 degrees to the mandibular plane. SNA-SNB difference was plus 1 degree.

Appraising this case according to the Howes analysis, we found that the canine fossa measurement was 45 mm. and the maxillary tooth material was 98 mm., giving us a ratio of 45 per cent. This placed the case into Group I, indicating no removal of dental units.

D. P. was then measured for the Rees analysis. The upper base measurement was 3 mm. greater than the upper teeth measurement. This is within the range of normal. The lower base was 8 mm. greater than the lower teeth measurement, which is high in the normal range. There were no modifying factors that would place the problem in anything but the nonextraction group. The upper base was 3 mm. less than the requirement of its relationship to the lower base, while the upper teeth, compared to the lower teeth, were well within the normal range, indicating that the upper denture and lower dentures were harmonious in so far as tooth size was concerned.

The Kesling analysis pointed to the need for tipping the lower incisors lingually 7 mm. if they were to have a 65-degree angulation with the Frankfort plane. The diagnostic setup showed that this could be done without extraction of teeth. Macroglossia could have a significant bearing on prognosis if it were present, but it was not.

Using the recording plex of Strayer on the mandibular teeth, practically all the units fell within their respective scratch markings on the Plexiglas. The maxillary teeth were mesial to the scratch marks by about the amount of Class II tooth relationship shown in the dental casts. On the basis of this analysis, the problem was judged as one not requiring extraction.

Case 3 is that of F. LeV., whose dental casts revealed a tooth relationship of the Class II, Division 2 variety. His profile was typical of this classification. As far as the skeletal pattern was concerned, he fit well within the Downs analysis range for normal. There was an SNA-SNB difference of 9 degrees, partially accounted for by the presence of posterior functional displacement of the mandible.

Measuring him for the Howes analysis, it was determined that canine fossa distance was 43 mm., while maxillary tooth material amounted to 97 mm. This produced a ratio of 44.3 per cent, with the patient falling into Group I, indicating no removal of dental units.

Analyzing the problem on the basis of Rees's standards, it might appear as if it were a borderline extraction case to which certain modifying factors could be applied. The relationship of the upper base to the upper teeth was 7 mm. less than the minimum, a disparity of enough significance to justify removal of dental units. However, the apical base measurement would be increased by the distal movement of the buccal segments by an appreciable amount. Lower base measurements, compared with lower tooth bulk, was 5 mm. less than the minimum, but might be improved as the bite opened, allowing some increase in lower base measurement.

According to Kesling, the lower incisors would only have to be moved 2 mm. lingually to place them at a 65-degree angle with the Frankfort plane. The diagnostic setup showed that this could be done without extraction of teeth.

Strayer's recording plex was laid over the occlusal surfaces of the mandibular teeth, and it was found that they were all placed pretty much within the scratch marks measured for them on the Plexiglas. This likewise was done on the maxillary teeth, disclosing that many of them were mesial to their scratch marks by less than the amount of Class II position as indicated on the dental casts. According to the Strayer analysis, this would not be an extraction case.

Proceeding now to the next case, that of T. H., certain general observations were made. Dental casts showed considerable crowding and a Class I tooth relationship. Upper 3's were blocked out and lower right 4 was missing. The bite tended to be open and the cephalogram implied that if all teeth were present and aligned there would be a bi-maxillary protrusion. Facial profile revealed none of the effects of the denture anomaly that was present. The patient was outside the Downs range of normals on everything except the angle of convexity. The Frankfort-mandibular plane angle was 38 degrees and the lower incisors were plus 1 degree to the mandibular plane. SNA-SNB difference was 3 degrees.

The canine fossa measurement was 33.3 mm. Maxillary tooth material proved to be 107 mm., placing the problem well within Group III, requiring premolar extractions. The arch width exceeded the canine fossa measurement, which Howes says is intolerable.

The Rees analysis discloses that the upper base bears a relationship to upper tooth material that is 9.5 mm. less than the minimum requirement for average normals. To bring the patient into that range, it is necessary to obtain space that is greater than one premolar and somewhat smaller than the width of two premolars. The base line cannot be increased by distal movement. Lower base to lower teeth is minus 3 mm., which is 5 mm. less than the minimum requirements. According to this survey, extractions are indicated, with a mild space closure problem involved.

The Kesling study shows that, to produce a 65-degree angle between the long axis of the mandibular incisor and the Frankfort plane, the lower incisors would have to be tipped lingually 7 mm. This cannot be done, according to the diagnostic setup, without removing four first premolars. The setup also

indicates that such a procedure would leave no space closing problem among the maxillary teeth, although it would leave a mild one with the mandibular teeth, as indicated in the Rees analysis.

Strayer's recording plex shows that the mandibular teeth could not be repositioned so that they would fall within their scratch marks on the Plexiglas without moving them posteriorly by an incredible amount. The same conclusion is reached when the recording plex is registered on the cast to the maxillary teeth. Again, extractions are indicated.

The final case to which these analyses will be applied is that of V. D. Her dental casts revealed an anomaly with tooth relationships that were borderline Class II, Division 1. The profile was acceptable, although it tended to be convex. This tendency in her profile was not nearly so evident as it was in her cephalogram, which showed an angle of convexity at the top extreme of the Downs analysis for ranges of average normals. The lower incisors were plus 12 degrees to the mandibular plane, while her Frankfort-mandibular plane angle was within Downs normals. In general, the teeth were slightly irregular with upper 3's partially blocked out of the dental arch in the maxillae.

ANALYSIS	PATIENTS				
	S. W.	D. P.	F. LeV.	T. H.	V. D.
Howes	Extraction	Nonextraction	Nonextraction	Extraction	Borderline
Rees	Borderline	Nonextraction	Borderline	Extraction	Borderline
Kesling	Extraction	Nonextraction	Nonextraction	Extraction	Extraction
Strayer	Borderline	Nonextraction	Nonextraction	Extraction	Nonextraction

Fig. 1.

From the standpoint of the Howes analysis, this would be judged as an extraction case, for the ratio between canine fossa and maxillary tooth material is 40.5 per cent. Inasmuch as distal movement of maxillary buccal segments is indicated, it is possible the canine fossa measurement may be increased by a slight amount, bringing the denture close to, but not within Group I. However, it resolves the case into the borderline extraction category. By a comparison of arch width against canine fossa measurement, there is no expansion opportunity. This is further prohibited by tense musculature. Any attempt to correct the borderline Class II tooth relationship would likely result in adding to the crowding already present among the lower incisors.

That the patient is a borderline extraction case is further indicated by the Rees analysis. Upper base to upper teeth is minus 6 mm., or 7.5 mm. less than the minimum of the normal range. This disparity will be improved somewhat as buccal teeth in the maxillae are moved distally, but such a gain will still leave the matter of extraction a borderline issue. The lower base relationship to the lower teeth is 3 mm. less than the minimum requirement, a lack which will doubtlessly be aggravated by Class II elastics.

Kessling's measurements show that the central incisors must be tipped lingually 6 mm. to reach a 65-degree angle with the Frankfort plane. The

diagnostic setup would indicate that this could not be done without removal of premolar teeth and that there would be a mild space closure problem in the lower denture.

Strayer's recording plex shows that all the mandibular teeth are placed so near the scratch marks provided for them on the Plexiglas that removal of premloars would provide about 10 mm. more space than is required. The plex indicates that removal of maxillary premolars would give about 12 mm. more space than is needed. His analysis could easily mean nonextraction with residual crowding.

Fig. 1 shows how the analyses compared with one another.

SUMMARY AND CONCLUSION

Case 1 (S. W.) was evaluated as an extraction case according to the Howes analysis and that of Kesling. There were two borderline conclusions on the case, which could result in the treatment proceeding in either direction relative to extractions. In the treatment of this case, I encountered a terrific space closure problem as the analyses predicted.

With respect to Case 2 (D. P.), all the analyses pointed to maintaining a full complement of teeth. The treatment result was satisfactory in most respects, except that the overbite was not sufficiently reduced and the profile did not reach expected standards. My experience with this case leaves me firmly convinced that the analyses were correct and that if I had employed extractions the results would have been even less satisfactory.

Three of the analyses on Case 3 (F. LeV.) indicated that his was a nonextraction problem, and the Rees evaluation produced evidence that he could be treated one way or the other. The patient was treated without extractions and is nearing completion of that treatment with results that substantiate the conclusions of the four analyses.

All the analyses seemed to agree that extractions were indicated in Case 4 (T. H.). Four premolars were extracted and results of treatment to date are a tribute to the accuracy of the analyses.

The fifth case (V. D.) turned out just the way you would expect in view of the varying conclusions indicated by the analyses. No extractions were made. Facial profile is excellent, although dental irregularities are still present. After occlusal equilibration, she is under no functional or esthetic handicap.

It has been quite an experience to relate the analyses of Howes, Rees, Kesling, and Strayer to each of these five cases. That they provide further opportunity to understand our daily challenges is, to me, a certainty.

REFERENCES

1. Nance, Hayes N.: Limitations of Orthodontic Treatment, AM. J. ORTHODONTICS AND ORAL SURG. **32**: 177-223, 253-301, 1947.
2. Carey, C. W.: Linear Arch Dimension and Tooth Size, AM. J. ORTHODONTICS **35**: 762-775, 1949.
3. Ballard, M. L., and Wylie, W. L.: Mixed Dentition Case Analysis—Estimating Size of Unerupted Teeth, AM. J. ORTHODONTICS AND ORAL SURG. **33**: 754-759, 1947.

4. Howes, A. E.: Case Analysis and Treatment Planning Based Upon the Relationship of the Tooth Material to Its Supporting Bone, AM. J. ORTHODONTICS AND ORAL SURG. **33**: 499-533, 1947.
5. Rees, Denton J.: A Method for Assessing the Proportional Relation of Apical Bases and Contact Diameters of the Teeth, AM. J. ORTHODONTICS **39**: 695-706, 1953.
6. Kesling, H. D.: The Philosophy of the Tooth Positioning Appliance, AM. J. ORTHODONTICS AND ORAL SURG. **31**: 297-304, 1945.
7. Kesling, H. D.: Personal Correspondence, 1954.
8. Tweed, Charles H.: The Frankfort-Mandibular Incisor Angle (FMIA) in Orthodontic Diagnosis, Treatment Planning and Prognosis, Angle Orthodontist **24**: 121-169, 1954.
9. Strayer, Edward Ray: Procedures for Case Evaluation and Analysis, AM. J. ORTHODONTICS **38**: 737-754, 1952.

661 FISHER BLDG.

A CEPHALOMETRIC APPRAISAL OF THE CURVE OF SPEE IN CLASS I AND CLASS II, DIVISION 1 OCCLUSIONS FOR MALES AND FEMALES

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INTRODUCTION

IN RECENT years there has been an increasing awareness of the necessity of making orthodontics more scientific to keep pace with the advances in technique. Clinical discoveries need a body of theory to unify and relate them, to point the way to new investigation and discovery. Long years of clinical experience have provided a body of empirical knowledge. A rational framework for this knowledge can increase the precision of diagnosis and the efficiency of treatment. Also, by codifying the clinical data and by making explicit the experienced orthodontist's understanding of the dentofacial complex, we can present the new member of the profession with the accumulated wisdom of his predecessors. It is in the hope of furthering this endeavor that the present paper was written.

Since 1907, when Edward H. Angle first proposed the categorizing of dental occlusion into three general classes, the value, definition, and application of these class distinctions have received a great share of research and controversy. Since the Class I and Class II, Division 1 occlusions account for some 95 per cent of all occlusions, research has focused on the differentiation of these two classes.

A review of this fairly extensive research literature provides the reader with little by way of generally accepted fact. Conflicting studies have been done on almost all the variables proposed.

The length of the mandible has been studied by a number of investigators, using several experimental methods. Adams[1] and Renfroe[25] conclude, on the basis of their test results, that there is no significant difference in this measurement between the two classes. Wylie[28] found no significant differences in mandible length of the two classes of males in his sample, but found the female Class II, Division 1 mandible significantly shorter than that of the Class I female. The results of Drelich,[13] Nelson and Higley,[23] and Gilmore[19] substantiate the hypothesis that the Class II, Division 1 mandible is significantly shorter than that of the Class I. Blair,[4] in his recent statistical analysis, found no signifi-

Condensation of the first honorable mention essay in the 1955 Prize Essay Contest of the American Association of Orthodontists, presented at the Research Section of the fifty-first annual meeting, San Francisco, May, 1955.

cant differences in length of mandible attributable to either class or sex, although a consistent non-significant difference was observed between males of Class I and Class II, Division 1.

Ramus height, although considered clinically to be related to mandible length, has received less study than the latter. Drelich[13] derived his hypothesis that Class II, Division 1 is characterized by a shorter ramus from a consideration of the facial skeletal pattern. He compared the ratios of upper to lower face (both anterior and posterior). From the different relations of posterior to anterior ratios in the two classes, he concluded that the Class II, Division 1 ramus was shorter than the Class 1 ramus. Craig[9] found no significant differences in ramus height between the two classes.

Gonial angle has also been investigated, and the preponderance of evidence seems to refute the hypothesis of significant differences in this variable between classes. In a later study, however, Blair[4] found a significantly greater angle in Class I than in Class II, Division 1, when sex influence was not controlled. Comparing these two classes on a like-sex basis, he found that the Class I male exhibited a significantly greater angle than the Class II, Division 1 male. This was not true for the female group, which revealed no significant angular difference.

The positions of the mandibular incisors were investigated in an attempt to fix the position of the anterior dental units within the two classes of malocclusion. Cortlett[11] derived an 8 mm. mean for the two groups studied by measuring the distance between a perpendicular line (erected from pogonion to the lower border of the mandible) at the greatest convexity of the central incisor. Markus,[22] together with Speidel and Stoner,[27] found a wide mean range for the anterior procumbency.

The relative position of the lower six-year molar is another variable used in comparing Class I and Class II, Division 1 malocclusions. Elman[15] derived a constant 3:2 ratio of horizontal to vertical distance when comparing Class I to Class II, Division 1. Gilmore,[19] however, found considerable variation in the molar position. Blair[4] found a significant positive correlation between the horizontal and vertical measurements to the mandibular first molar.

When the skeletal pattern was considered, conflicting results were likewise found. Renfroe,[25] using the angle SN-ANS, found the angle to be more open in Class II, Division 1 than in Class I. Reidel, using a Down's analysis, found no differences in the anterior position of the maxilla between the Class II, Division 1 and the Class I patterns. Blair[4] supports Renfroe's finding. The relative position of the mandible to the cranium is another of the skeletal pattern variables studied. Baldridge,[2] using the angle N-S-GN, found the Class II, Division 1 mandible to be in a more posterior position relative to the cranium than that of Class I. Renfroe[25] found point gnathion of Class II, Division 1 to have a more posterior position than that of Class I, basing his conclusion on measurement of the AB plane to the facial plane.

PROBLEM

It is our contention that the lack of concord in experimental studies is based on sampling method (consideration of age, sex, sample size, and adequate definition of the constructed sample groups), accuracy of testing, and statistical analysis. This study attempts to define and select adequate sample groups; to test these defined samples of Class I and Class II, Division 1 occlusions for the diagnostic clinical criteria commonly used in differentiating them; and to consider a further variable, which has received surprisingly little attention throughout this long research controversy—the shape, position, and relation in class and sex of the curve of Spee. The steps in the experimental procedure were as follows:

A. *Defining the Sample and Establishing the Variables Which Differentiate the Classes*

1. The sample was selected on the basis of Angle's classification of molar relationships.

2. Establishing class differentiation and assessing the influence of sex differences with respect to:

(a) Anterior skeletal pattern, through measurement and comparison of ANB angle (difference between SNA and SNB) and SN-AB angle.*

(b) Length of body of mandible (border length).

(c) Ramus height.

(d) Gonial angle.

B. *Assessing the Characteristics of the Curve of Spee for Males and Females in Class I and Class II, Division 1*

1. The position of contact points† on the curve of Spee, compared by class and sex.

2. Position of each contact point on the curve of Spee, in relation to the body of the mandible and the ramus, compared by class and sex.

3. Position of the curve of Spee in relation to the body of the mandible and the famus, compared by class and sex.

4. Shape of the curve of Spee, compared by class and sex.

SAMPLING AND DEFINING THE GROUPS

A. *Initial Selection.*—One hundred subjects were chosen, with an equal proportion of males and females and equal representation of the two classes, twenty-five subjects in each sex-class group (Class I females, Class I males,

*See Fig. 1. ANB angle here indicates the relationship of maxilla to mandibles; SN-AB angle indicates the relationship (procumbency or retrusion) of maxilla and mandibles to cranial base.

†The contact point was not arbitrarily chosen in describing the curve of Spee but, after many successive tracings on cephalometric roentgenograms, it was found very inaccurate to pick out the tip of the cusps of the teeth. The contact points were tested and found to be easily traced and accurate. In making this transfer, it was realized that this was not the true curve of Spee as defined but, since the contact points were equidistant from the cusp tip throughout the full complement of teeth, the curve of Spee defined by contact points will be identical with that defined by cusps.

Class II, Division 1 females, and Class II, Division 1 males). The Angle classification of occlusion was used in this initial selection. All subjects were Caucasians, 18 years of age* or over for females, 20 years of age or over for males; all had a full complement of teeth. None of the subjects had received orthodontic treatment. By thus limiting the sample, the possible influence of irrelevant variables was minimized. Ethnic variation was controlled by limiting the sample to Caucasian stock. The important factor of relative advancement in the growth cycle was controlled by choosing subjects above the age commonly accepted for maturity of the face and jaws.

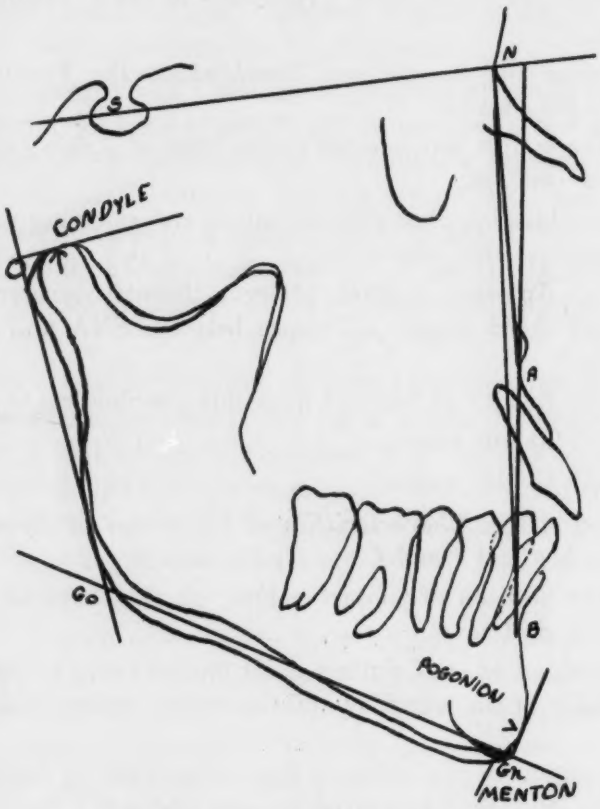

Fig. 1.—Tracing of cephalometric roentgenogram.

B. *Refining the Classification.*—

Collecting the data: Cephalometric roentgenograms were taken of all subjects. The instrument employed was a Margolis cephalostat with an x-ray tube at five-foot target distance, in accordance with the standard technique devised by Broadbent.[6] Two lateral head roentgenograms were taken in each case, one in centric and one in rest position.† The variables to be compared were transferred from roentgenograms to millimeter graph paper by two steps. First,

*Male age ranges were 20 to 34 years for Class I, 20 to 29 years for Class II, Division 1, with mean age of 25.2 and 22.2 years, respectively. Female age ranges were 18 to 26 for Class I, 18 to 31 years for Class II, Division 1, with mean ages of 19.3 and 20.4, respectively.

†The exposure was 65 KVP and 25 Ma. at three seconds on an Eastman Blue Brand 10 by 12 film. Standard procedure for developing film was used.

tracings were made on the left side of each roentgenogram. Wherever bilateral structures were considered, a mean value was computed for the two sides and this value was used in comparisons. The error factor was found to be less than .75 per cent between investigators, and less than .50 per cent for the individual investigator. Reliability of this order is more than adequate for validation. Figs. 1 and 2 illustrate lifting of the tracings from the roentgenograms and their transference to graph paper in the form of geometrical coordinates.

Coordinates were plotted from the following six points:

1. The highest discernible point of contact of the central incisor.

2. The contact areas between: (a) canine and first premolar; (b) first premolar and second premolar; (c) second premolar and first molar; (d) first molar and second molar; and (e) second molar and third molar (where there was no third molar, the highest and most distal point on the distal surface of the second molar was used).

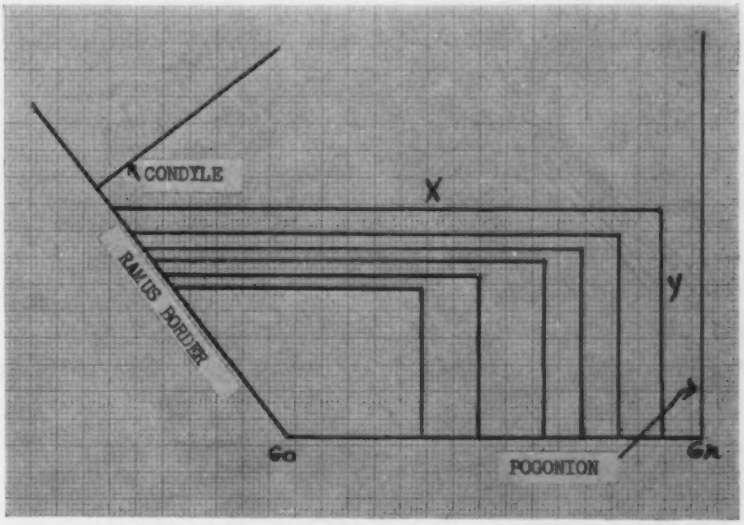

Fig. 2.—A tracing transferred to millimeter graph paper.

Perpendicular lines were dropped to the GN-GO line (see diagram) from the contact points. This set of lines constitutes the Y axis. Parallel lines to the GO-GN line were constructed from the contact points to intersect the line tangent to the ramus of the mandible. The parallels constitute the X axis. The millimeter measurements in the X and Y coordinates place the areas or points on the occlusal curvature in two planes of space.

Planes used in the study are:

1. Mandibular border (see Fig. 1), a line tangent posteriorly to the most inferior-posterior point on the mandible and anteriorly to menton

2. Ramus border (see Fig. 1), a line tangent superiorly to the most outward projection on the condyle and inferiorly to extreme posterior-inferior part of the ramus.

Points described: (1) sella, (2) nasion, (3) point A, (4) point B, (5) menton, and (6) gonion (Fig. 1).

Angles described: (1) ANB (equal to difference between SNA and SNB), (2) SN-AB, (3) gonial angle (Fig. 1).

Linear measurements:

1. Mandibular length (coordinate X), millimeter measurement from the intersection of the mandibular border and ramus to a line tangent to the anterior position of the symphysis (pogonion) and perpendicular to the mandibular border.

2. Ramus height, millimeter measurement from a point superiorly where a perpendicular is erected to the ramus border and tangent to the most superior aspect of the condyle and inferiorly to where a lower border line touches this line at gonion.

Once the angle measurements were made and the contact points were measured and plotted with reference to the X and Y coordinates, it was possible to compare all the variables studied:

1. Class II, Division 1 female and Class II, Division 1 male.
2. Class I female and Class I male.
3. Class II, Division 1 female and Class I female.
4. Class I male and Class II, Division 1 male.
5. Class II, Division 1 female and Class I male.
6. Class I female and Class II, Division 1 male.
7. Class I male and female and Class II, Division 1 male and female.

To evaluate the results of these comparisons, the reliability of found differences was checked against the standard error of the differences between two means for the groups studied. This procedure was carried out for each comparison.

In this part of the stuly (differentiation of classes), comparisons were made between the means of the various groupings, and the differences evaluated, for:

1. The anterior skeletal pattern of the face (as expressed by angles ANB and SN-AB).
2. Border length.
3. Ramus height.
4. Gonial angle.

It is our belief that certain relationships between gonial angle, ramus height, and border length are constant, and it was thought that differences in these relationships might further differentiate Class I and Class II, Division 1 occlusions.

TABLE I. SUMMARY OF MEANS AND STANDARD DEVIATIONS FOR BORDER LENGTH, RAMUS HEIGHT, GONIAL ANGLE, ANB ANGLE, AND SN-AB ANGLE

	BORDER LENGTH	RAMUS HEIGHT	GONIAL ANGLE	ANB ANGLE DIFFERENCE (SNA-SNB)	SN-AB ANGLE
Class I, male					
Mean	90.42	69.80	118.99	1.84	76.04
Standard deviation	3.97	5.63	5.45	2.33	5.03
Class II, Division 1 male					
Mean	88.61	68.42	119.51	4.39	70.97
Standard deviation	5.66	5.05	5.43	1.85	4.90
Class I female					
Mean	85.09	61.42	120.40	2.40	76.00
Standard deviation	4.82	4.88	5.91	2.59	5.07
Class II, Division 1 female					
Mean	82.86	59.98	122.96	3.73	71.17
Standard deviation	3.72	4.23	7.42	1.98	5.48
Class I male and female					
Mean	87.76	65.61	119.70	2.11	76.02
Standard deviation	5.13	6.72	5.67	2.45	5.00
Class II, Division 1 male and female	85.68	64.11	121.27	4.01	71.08
Mean					
Standard deviation	5.54	6.27	6.68	1.93	5.18

Product moment correlations were calculated between angles and linear measurements for each sex-class group. (Correlation values are given in Table IV.) For purposes of better understanding the relationship between the three measurements, partial correlations were computed for these measurements, permitting the comparisons of all possible pairings among the three variables (for correlation values, see Table IV).

The correlations and partial correlations computed for the relationship between these three measures were then compared (as indicated in the previous diagram) and the significances of found differences were evaluated by the t test (see Table II).

C. *Characteristics of the Curves of Spee.*—The second step in the treatment of the data was the comparison of the characteristics of the curves of Spee for Class I and Class II, Division 1 and for males and females. Some of the comparisons outlined above in the differentiation of Class I and Class II, Division 1 were also used in comparing the curves of Spee by class and sex. The relevant comparisons are:

1. Distances of each contact point from the lower border of the mandible (Y coordinate).

2. Distances of each contact point from the posterior border of the ramus (X coordinate).

3. Correlation between X and Y coordinates for each point.

Each of these three measurements was compared for class differences and for sex differences.

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1. Class II, Division 1 female and Class II, Division 1 male.
2. Class I female and Class I male.
3. Class II, Division 1 female and Class I female.
4. Class I male and Class II, Division 1 male.
5. Class II, Division 1 female and Class I male.
6. Class I female and Class II, Division 1 male.
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1. Distances of each contact point from the lower border of the mandible (Y coordinate).

2. Distances of each contact point from the posterior border of the ramus (X coordinate).

3. Correlation between X and Y coordinates for each point.

Each of these three measurements was compared for class differences and for sex differences.

ANALYSIS OF DATA AND CONCLUSIONS

A. *Differentiating the Classes.—*

Angle comparisons: The angle ANB is a measurement of the relationship of maxilla to mandible, and the angle SN-AB delineates a relationship of cranial base to maxilla and mandible position. These describe the skeletal pattern of the front of the face. Class II, Division 1 malocclusions with recessive lower jaw are frequently referred to collectively as the "Andy Gump" pattern, described by Ricketts[26] as follows: ". . . the Class II, Division 1 skeletal pattern is characterized by an abnormal anterior-posterior relation of the dental arches and jaws, the mandible being back or the maxilla forward of normal to the extent of one full cusp, when the teeth are occluded. . . ." The present

TABLE II. t SCORES SHOWING SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS FOR BORDER LENGTH, RAMUS HEIGHT, GONIAL ANGLE, ANB ANGLE, AND SN-AB ANGLE

	BORDER LENGTH	RAMUS HEIGHT	GONIAL ANGLE	ANB ANGLE DIFFERENCE (SNA-SNB)	SN-AB ANGLE
Class II, Division 1 male Class II, Division 1 female	4.1294	6.2325	−1.8123	1.1000	−0.1193
Class I male Class I female	4.2674	5.6242	−0.8769	−0.7909	0.0277
Class I female Class II, Division 1 female	1.8130	1.0992	−1.3403	1.9851	3.1776
Class I male Class II, Division 1 male	1.2929	0.8903	−0.3312	−3.8636	3.2922
Class I male Class II, Division 1 female	6.8727	6.8617	−2.1459	−3.0484	3.2467
Class II, Division 1 male Class II female	2.3311	4.8951	−0.5427	2.7639	−3.2244
Class I and Class II, Division 1 male and female	1.9259	1.1364	−1.2460	−4.0426	4.6168

t scores outside the limits of ± 2.797 are significant at the 1 per cent level.
t scores outside the limits of ± 2.485 are significant at the 2 per cent level.
t test for 25, above; t test pooled 50, below.
t scores outside the limits of ± 2.576 are significant at the 1 per cent level.
t scores outside the limits of ± 2.263 are significant at the 2 per cent level.

study arrives at the same conclusion by the results of comparisons of these two angles. No significant sex-determined differences were found, but class differentiations are present for both angles in each of the sex groups and sex-pooled groups (see Table II). This findings means that the anterior skeletal pattern of the faces for Class I malocclusions differs from the pattern of Class II, Division 1 and that the facial skeletal pattern can be used as a diagnostic indicator, supplementing Angle classification.

Border length (Table II): Significant differences were found between the sex groups in border length. Comparisons between Class I and Class II, Division 1 showed no significant differences in border length where the influence of sex differences was eliminated. This is not in agreement with the prepon-

derance of experimental data of Wylie,[28] Nelson and Higley,[23] and Gilmore.[19] Blair[4] agrees in the direction of sex differences (male mandible length greater than female mandible length), although his results do not reach the level of significance that ours do.

Ramus height (Table II): As in the case of the mandible length, sex differences were found, but no differences were found between classes when this factor was controlled. Little work has been done previously on ramus height independent of mandible length. This study refutes the conclusions of Drelich,[13*] who found a class difference in ramus height, but agrees with the later study of Craig.[9] Thus, it can be said that ramus height and mandible length are not concerned in defining Class I and Class II, Division 1 subjects. Between-sex differences found may be of considerable significance. A full discussion of this point will be found under "Summary and Concluding Statement."

Gonial angle (Table II): No significant differences were found in gonial angle, due to either class or sex differentiation, with one exception. This one exception is at the 5 per cent level, *not* at the 1 or 2 per cent level where the tests in this study were analyzed, and is found where females of Class II, Division 1, exhibiting the larger female gonial angle, were compared with males of Class I, exhibiting the smaller male gonial angle. For this one comparison, a significant difference was found. The Class II, Division 1 female gonial angle was found to be significantly larger than the Class I male gonial angle.

This difference is attributed to the sex-class interaction in the groups compared. Until 1954, research on gonial angle differentiation[1, 9, 19, 25] had yielded no significant class differences in gonial angle. Blair[4] finds Class I gonial angle larger than Class II, Division 1 gonial angle, in disagreement with the previous studies and with the major findings of this study relative to gonial angle.

A separate statistical study was made to determine the origin of the single discrepancy in results of gonial angle comparisons (Table III). It was felt that an explanation might be found in different border length/ramus height relations between males and females. It was first established that the ratios of ramus height to border length were the same for males of Class I and Class II, Division 1. The same equality of ratio was established for females of both classes. In comparing the ratios of male and females of the same class, however, the ratios were significantly different for both classes. This finding supports the original contention that this discrepancy is based on a sex difference rather than a true difference in gonial angle between the two classes. This sex differential, like those for ramus height and mandible length, is further discussed under "Sex Conclusion."

Correlation between gonial angle, ramus height, and border length: The same reasoning which led clinicians to speculate about class differences in the separate factors (ramus height, mandible length, and gonial angle) gave rise to similar speculation about possible relation between these three factors. Al-

*See "Introduction" for full description of this study.

TABLE III. COMPARISON OF BORDER LENGTH/RAMUS HEIGHT RATIOS

1. *If ratios of males and females are equal:*

A. $\frac{\text{Ramus height (M)}}{\text{Border length (M)}} = \frac{\text{Ramus height (F)}}{X}$

and

B. $X = \frac{\text{Border length X Ramus height (F)}}{\text{Ramus height (M)}}$

2. *Comparisons of ratios between classes (same sex):*

A. Class I male — Class II, Division 1 male

$\frac{70}{90.5} = \frac{68.5}{X}$ $X = 88.5$ expected; $X = 88.5$ actual

B. Class I female — Class II, Diivsion 1 female

$\frac{61.5}{85} = \frac{60}{X}$ $X = 83$ expected; $X = 83$ actual

3. *Comparisons of ratios between sexes (same class):*

A. Class I male — Class I female

$\frac{70}{90.5} = \frac{61.5}{X}$ $X = 79.5$ expected; $X = 85$ actual

Difference 5.5

X 0.96

t test $5.5 \div 0.96 = 5.73$

B. Class II, Division 1 male — Class II, Division 1 female

$\frac{68.5}{88.5} = \frac{60}{X}$ $X = 77.5$ expected; $X = 83$ actual

Difference 5.5

X 0.74

t test $5.5 \div 0.74 = 7.43$

Differences significant in both cases above the 99 per cent level of significance. Similar comparisons were made, with mandible length given and solving for ramus height, with the same results.

TABLE IV. CORRELATION VALUES: BORDER LENGTH AGAINST GONIAL ANGLE, RAMUS HEIGHT AGAINST GONIAL ANGLE, AND BORDER LENGTH AGAINST RAMUS HEIGHT

	PRODUCT MOMENT CORRELATIONS			PARTIAL CORRELATIONS*		
	BORDER LENGTH GONIAL ANGLE	RAMUS HEIGHT GONIAL ANGLE	BORDER LENGTH RAMUS HEIGHT	1 12.3	2 13.2	3 23.1
Class I male	0.0523	−0.6907	−0.1058	−0.0964	−0.0289	−0.6900
Class II, Division 1 male	−0.4759	−0.4328	0.1808	−0.0317	−0.4485	−0.4010
Class I female	−0.3890	−0.4708	0.1503	−0.0404	−0.3606	−0.4526
Class II, Division 1 female	−0.2111	−0.3887	0.0238	−0.0648	−0.2193	−0.3926
Class I male and female	−0.2342	−0.5266	0.3475	0.2712	−0.0643	−0.4882
Class II, Division 1 male and female	−0.4054	−0.4586	0.4333	0.3043	−0.2581	−0.3514

*1 = Border length; 2 = ramus height; 3 = gonial angle.

though it was never systematically demonstrated, it was believed by some that a consistent relationship existed between the three and that this relationship varied from Class I to Class II, Division 1. This study statistically tests both hypotheses and finds that neither is experimentally justified. The correlations and partial correlations between gonial angle, ramus height, and border length were found to be non-significant in seventeen of the eighteen partial correlations (Table IV). In one case (the correlation of ramus height to gonial angle of the Class I male) the relationship is significant. The same degree of correspondence appears in the partial correlation, in which the influence of border length does not enter into the correlation. Although the reason for this single exception is not clear, it cannot seriously affect the general trend of the result, which clearly negates any constant relationship between these three variables.

When the correlations are compared by class and sex, no differences are found to be significant at or above the 98 per cent level (Tables IV and V). We thus can conclude that, for class or sex, no constant relationship exists between border length, ramus height, and gonial angle.

TABLE V. t SCORES OF VARIOUS INTERGROUP COMPARISONS OF THE FOLLOWING CORRELATIONS: BORDER LENGTH AGAINST GONIAL ANGLE, RAMUS HEIGHT AGAINST GONIAL ANGLE, AND BORDER LENGTH AGAINST RAMUS HEIGHT

	BORDER LENGTH AND GONIAL ANGLE	RAMUS HEIGHT AND GONIAL ANGLE	RAMUS HEIGHT AND BORDER LENGTH
Class II, Division 1 male Class II, Division 1 female	−0.9711	−0.1698	0.5089
Class I male Class I female	1.7205	−1.122	−0.8547
Class I female Class II, Division 1 female	0.6431	−0.3304	0.4152
Class I male Class II, Division 1 male	2.0252	−1.2495	0.9354
Class I male Class II, Division 1 female	1.0555	−1.4389	−0.4261
Class II, Division 1 male Class I female	−0.3465	0.1547	0.1015
Class I female and male Class II, Division 1 female and male (50)	0.9127	−0.4287	−0.4832

t test No. 25.
t scores outside the limits of ±2.797 are significant at the 1 per cent level.
t scores outside the limits of ± 2.492 are significant at the 2 per cent level.
t test No. 50.
t scores outside the limits of ± 2.576 are significant at the 1 per cent level.
t scores outside the limits of ± 2.263 are significant at the 2 per cent level.

B. *The Characteristics of the Curves of Spee, Assessed for Class Differences and Sex Differences.*—Clinical observation led to the hypothesis that Class II, Division 1 central incisors were supra-erupted, and/or that the premolars and first molars were infra-erupted, and the resultant curve of Spee for Class II, Division 1 was deeper. It was our hypothesis that the apparent supra-eruption of the central incisors (which sometimes strike the roof of the mouth) is actually

caused by a difference in the position of the mandible or maxilla. This difference in position would move the maxillary first molar into occlusion with the premolars instead of the first permanent molar. The mandibular second premolar does, indeed, represent a deeper part of the curve of Spee for both classes, but the present study hopes to show that it is the relative position of the whole curve, rather than a difference in the actual depth of the curve, that accounts for this observed characteristic of the Class II, Division 1 occlusion. This section of the study is an attempt to validate the hypothesis.

As was outlined in "Sampling and Defining the Groups," the positions of six contact points, from central incisor to third molar, were plotted for each subject relative to the lower border of the mandible and the posterior ramus. The distances were then measured from each point to these two axes. The millimeter distance from contact point to ramus was called the X coordinate for the contact point, and the millimeter distance from the contact point to the mandible was called the Y coordinate of the contact point. Thus, for each individual in the sample, each contact point was determined with respect to the two borders. The line formed by connecting the six contact points is the individual's curve of Spee, as defined in this study.

TABLE VI. MEAN AND STANDARD DEVIATION OF THE CENTRAL INCISOR COORDINATES FOR CLASS I AND CLASS II, DIVISION 1 MALES AND FEMALES AND POOLED SEXES

	$\bar{Y}$	σ_Y	$\bar{X}$	σ_X
Class I Males	46.24	2.203	103.0	5.291
Class II, Division 1 Males	45.80	3.391	102.2	6.082
Class I Females	41.84	3.056	98.56	5.307
Class II, Division 1 Females	42.40	2.915	99.60	7.522
Class I (Males and females)	44.04	3.253	100.78	5.71
Class I, Division 1 (Males and Females)	44.10	3.570	100.90	6.89

From these data, means were computed for each class and sex category (for both X and Y coordinates) for the position of each contact point: The X and Y coordinates determining the position of each contact point were summed, for instance, for Class I males and means were computed. These means represent the average position of each of the six contact points for the Class I male group. Connecting the six average positions then gives us the average curve of Spee for males of Class I. The same procedure was used for computing "average curve of Spee" for all other groupings. The average curve of Spee defined for this study is the line connecting the means of the six contact points for the particular class or sex group considered (Tables VI to XI).

Shapes of the curves: Fig. 3 shows the seven class-sex comparisons of the average curves of Spee defined by mean positions of contact points. The curves

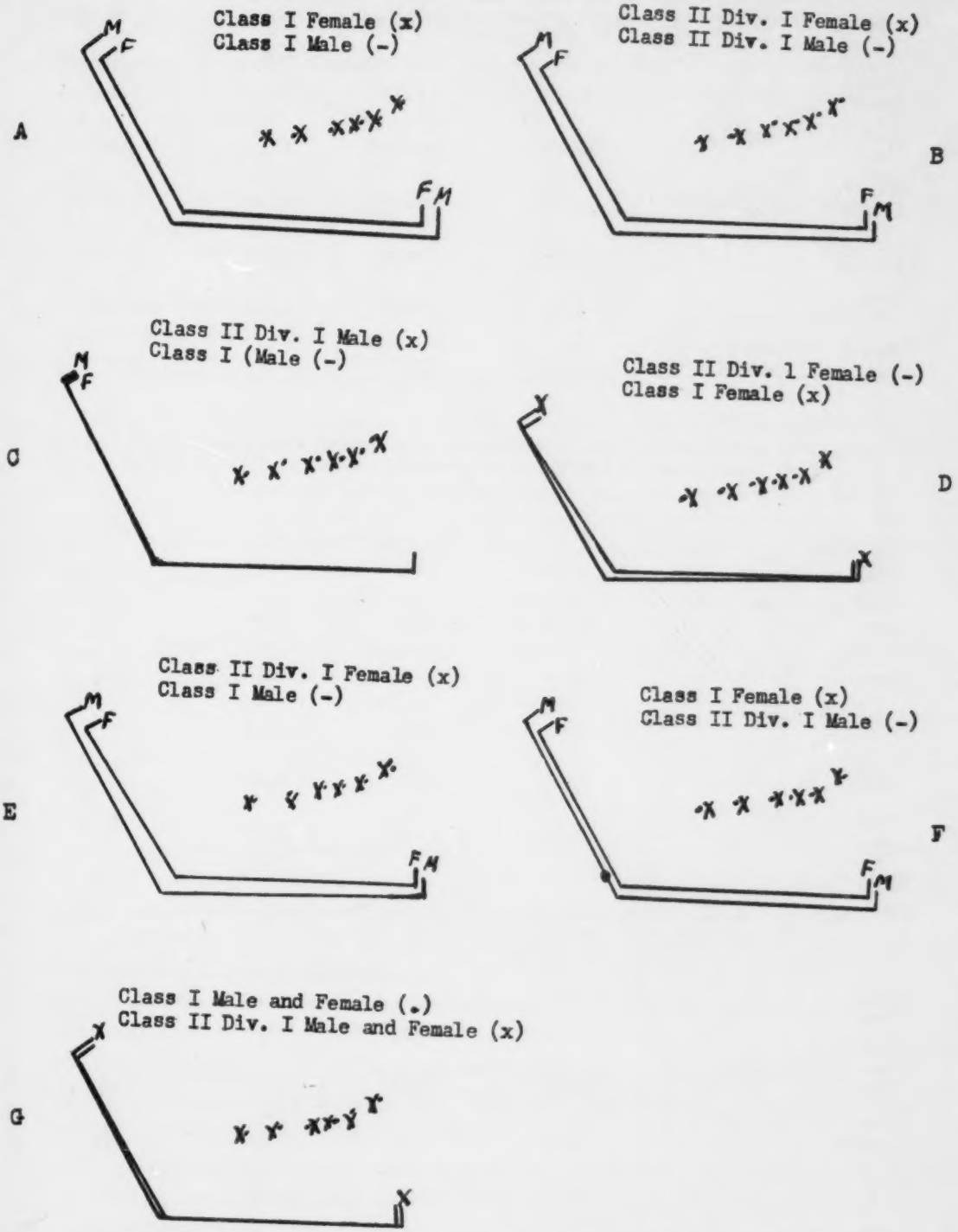

Fig. 3.—Composite showing superposition of mean arcs constructed from the X and Y coordinates from the contact points on the curve of Spee.

TABLE VII. MEAN AND STANDARD DEVIATION OF THE FIRST PREMOLAR COORDINATES FOR CLASS I AND CLASS II, DIVISION 1 MALES AND FEMALES AND POOLED SEXES

	$\bar{Y}$	σ_Y	$\bar{X}$	σ_X
Class I Males	41.16	2.374	92.24	6.296
Class II, Division 1 Males	39.68	3.338	89.80	4.932
Class I Females	36.0	3.175	87.68	5.580
Class II, Division 1 Females	36.04	2.683	87.28	6.642
Class I (Males and females)	38.58	3.807	90.04	5.728
Class II, Division 1 (Males and Females)	37.86	3.518	88.54	5.93

TABLE VIII. MEAN AND STANDARD DEVIATION OF THE SECOND PREMOLAR COORDINATES FOR CLASS I AND CLASS II, DIVISION 1 MALES AND FEMALES AND POOLED SEXES

	$\bar{Y}$	σ_Y	$\bar{X}$	σ_X
Class I Males	38.92	2.58	84.56	5.331
Class II, Division 1 Males	37.76	3.212	81.08	4.915
Class I Females	34.16	3.036	79.60	5.033
Class II, Division 1 Females	34.0	2.466	78.96	6.194
Class I (Males and females)	36.54	3.687	82.08	5.710
Class II, Division 1 (Males and Females)	35.88	3.414	80.02	5.636

TABLE IX. MEAN AND STANDARD DEVIATION OF THE FIRST MOLAR COORDINATES FOR CLASS I AND CLASS II, DIVISION 1 MALES AND FEMALES AND POOLED SEXES

	$\bar{Y}$	σ_Y	$\bar{X}$	σ_X
Class I Males	37.93	2.462	76.08	5.548
Class II, Division 1 Males	36.70	3.050	74.63	4.365
Class I Females	33.09	2.590	71.56	5.280
Class II, Division 1 Females	32.70	3.000	70.71	6.778
Class I (Males and females)	35.51	3.498	73.82	5.825
Class II, Division 1 (Males and Females)	34.70	3.612	72.67	5.980

TABLE X. MEAN AND STANDARD DEVIATION OF THE SECOND MOLAR COORDINATES FOR CLASS I AND CLASS II, DIVISION 1 MALES AND FEMALES AND POOLED SEXES

	$\bar{Y}$	σ_Y	$\bar{X}$	σ_X
Class I Males	35.66	2.562	62.93	5.135
Class II, Division 1 Males	34.58	2.912	60.87	3.565
Class I Females	30.76	2.660	58.72	5.050
Class II, Division 1 Females	30.09	2.875	57.47	5.800
Class I (Males and females)	33.21	3.578	60.82	5.470
Class II, Division 1 (Males and Females)	32.34	3.655	59.17	5.065

TABLE XI. MEAN AND STANDARD DEVIATION OF THE THIRD MOLAR COORDINATES FOR CLASS I AND CLASS II, DIVISION 1 MALES AND FEMALES AND POOLED SEXES

	$\bar{Y}$	σ_Y	$\bar{X}$	σ_X
Class I Males	32.55	2.902	49.20	4.922
Class II, Division 1 Males	32.16	3.680	46.94	4.250
Class I Females	28.27	2.858	45.40	4.815
Class II, Division 1 Females	27.31	3.142	43.89	5.475
Class I (Males and females)	30.41	3.578	47.30	5.188
Class II, Division 1 (Males and Females)	29.74	4.180	45.42	5.090

of Spee are superimposed for geometrical visual comparison; inspection of this set of drawings makes apparent the similarity of curves of Spee, for both class and sex comparisons. However, judgment by inspection is an undependable criterion for scientific validation. In order to evaluate this apparent similarity, the mean positions, in terms of X and Y coordinates were compared by class and sex.

Class differences: In no case did the differences between Class I and Class II, Division 1 reach significance. By the t test (see Table XII), we may thus conclude (see also Tables XIII and XIV):

1. That the average positions of the six contact points measured are the same for Class I and Class II, Division 1 for the X and Y coordinate.

2. That the average curves of Spee connecting these points are also identical for Class I and Class II, Division 1.

TABLE XII. t SCORES SHOWING THE SIGNIFICANCE OF DIFFERENCE BETWEEN MEANS OF X COORDINATES IN CLASS I AND CLASS II, DIVISION 1 MALES AND FEMALES

	CENTRAL	FIRST PRE-MOLAR	SECOND PRE-MOLAR	FIRST MOLAR	SECOND MOLAR	THIRD MOLAR
Class II, Division 1 female Class II, Division 1 male	1.354	1.527	1.340	2.430	2.495	2.200
Class I female Class I male	2.912	2.710	3.383	2.950	2.920	2.760
Class II, Division 1 female Class I female	0.565	0.023	0.401	0.495	0.812	1.035
Class II, Division 1 male Class I male	0.496	1.525	2.40	1.025	1.650	1.740
Class II, Division 1 female Class I male	2.207	2.692	3.427	3.065	3.525	3.605
Class I female Class II, Division 1 male	2.236	1.423	0.751	2.240	1.740	1.200

Refer to significance figures, Table II.
N = 25.

TABLE XIII. t SCORES SHOWING THE SIGNIFICANCE OF DIFFERENCE BETWEEN MEANS OF Y COORDINATES IN CLASS I AND CLASS II, DIVISION 1 MALES AND FEMALES

	CENTRAL	FIRST PRE-MOLAR	SECOND PRE-MOLAR	FIRST MOLAR	SECOND MOLAR	THIRD MOLAR
Class II, Division 1 female Class II, Division 1 male	3.80	6.74	4.641	4.675	5.485	5.010
Class I female Class I male	5.85	6.60	5.979	6.770	6.630	5.255
Class II, Division 1 female Class I female	0.664	0.048	0.205	0.490	0.855	1.130
Class II, Division 1 male Class I male	0.545	1.82	1.406	1.570	1.390	0.415
Class II, Division 1 female Class I male	5.26	7.09	6.90	6.740	7.230	6.125
Class I female Class II, Division 1 male	4.351	5.762	4.072	4.510	4.840	4.175

Refer to significance figures, Table II.
N = 25.

TABLE XIV. t SCORES SHOWING THE SIGNIFICANCE OF DIFFERENCE BETWEEN MEANS OF X AND Y COORDINATES IN CLASS I AND CLASS II, DIVISION 1, AND POOLED SEXES

	T TEST	CENTRAL	FIRST PRE-MOLAR	SECOND PRE-MOLAR	FIRST MOLAR	SECOND MOLAR	THIRD MOLAR
Class I male and female Class II Division 1 male and female	X	0.950	1.293	1.823	0.974	1.565	1.834
Class I male and female Class II Division 1 male and female	Y	0.0881	0.829	0.092	1.139	1.217	0.874

Refer to significance figures, Table II. Number 50.

Sex differences:

1. Comparison of curves of Spee for men and women is complicated by the fact that there is a difference in magnitude of both of the coordinates of the curve between the two sexes.* If it could be demonstrated that sex comparisons of all contact points show the same magnitude of difference for both X and Y coordinates, we could say that the average curves of Spee in men and women have the same shape (since all the contact points would be in the same position relative to each other) and that the curves are a different distance from the mandible. Conversely, if we could demonstrate that the coordinates for different contact points do *not* differ by a constant amount, we could conclude that these curves differ in shape.

The male/female comparison of the curves of Spee can be made by calculating confidence intervals† for the inter-sex differences between X coordinates, and similarly for Y coordinates. This is shown in Table XV.

TABLE XV. CONFIDENCE INTERVALS* OF DIFFERENCES BETWEEN MEANS, IN COMPARISONS BETWEEN SEXES OF THE X COORDINATES FOR INDIVIDUAL CONTACT POINTS (CLASS CONSTANT) AND OF THE Y COORDINATES (CLASS CONSTANT)

TOOTH	X COORDINATE (MMS)	Y COORDINATE (MMS)
	Class I	
Central incisor	0.57- +8.31	2.45- −6.35
First premolar	0.22- −8.90	3.11- −7.21
Second premolar	0.96- −8.96	2.46- −7.06
First molar	0.56- −8.48	3.00- −6.68
Second molar	0.27- −8.15	2.99- −6.81
Third molar	0.25- −7.35	2.18- −6.38
	Class II, Division 1	
Central incisor	(−2.42)†- −7.62	1.09- −5.71
First premolar	(−1.95)- −6.59	1.43- −5.85
Second premolar	(−1.96)- −6.20	1.67- −5.85
First molar	(−0.24)- −8.08	1.79- −6.21
Second molar	(−0.11)- −6.91	2.38- −6.60
Third molar	(−0.52)- −6.62	2.35- −7.25

*At 99 per cent level of significance.

†Negative numbers denote differences opposite in direction to the actually obtained mean for this sample.

Examination of Table XV shows that, within each class, confidence intervals for differences in either coordinate of a given contact point show very close similarity. From this we can conclude that there is a high probability that the average curves of Spee for men and women tend to be identical in shape. We cannot, on the basis of this information, eliminate the possibility that there are small true differences in shape between the two curves. However, the magnitude of possible true differences is minimized by the fact that we can predict, from common biologic observation, positive correlations between both sets of coordinates for the various contact points. That is, if one contact

*X measurements and Y measurements for males are consistently larger than those for females.

†A confidence interval at 99 per cent level of significance is an interval within which one can be 99 per cent confident of finding the true value.

point is relatively far from the mandible border and/or ramus, so will be the adjoining contact point. This means that the differences between contact points for the two curves will reflect actual similarities in the curves.

It was also obvious from the calculations of X and Y for the six contact points that the position of each point for females was closer to both borders, making the average curve for females smaller and similar in shape (see Fig. 4).

2. *Relation of the curve of Spee to the borders.* In order to understand more fully the relationship between dimensions of the curve of Spee, product moment correlations were computed between linear measurements of X and Y. The purpose of this computation was to detect the consistent relationship, if any, between these two measurements. Results (Table XVI) were as follows:

1. Central incisor correlation is good to fair for males and females of both classes.

2. First premolar correlation is fair to good.

3. Second premolar correlation is only fair. (There is a greater drop in correlation value here than from central incisor to first premolar.)

4. First molar correlation is fair to good.

5. Second molar correlation is only poor to fair.

6. Third molar contact shows a very poor correlation.

7. There is a progressive decrease in the correlations from central incisor posteriorly to the third molar contact point (except for the first molar contact) for males and females of both classes.

TABLE XVI. CORRELATION VALUES: X COORDINATE TO Y COORDINATE OF THE CONTACT POINTS IN MALES AND FEMALES OF CLASS I AND CLASS II, DIVISION 1 OCCLUSION

	CENTRAL	FIRST PREMOLAR	SECOND PREMOLAR	FIRST MOLAR	SECOND MOLAR	THIRD MOLAR
Class I Males	0.5466	0.497	0.4848	0.4806	0.3061	0.2278
Class II, Division 1 Males	0.6443	0.632	0.3437	0.6239	0.4267	0.3237
Class I Females	0.7082	0.639	0.5740	0.5153	0.4504	0.2627
Class II, Division 1 Females	0.5015	0.511	0.4445	0.4888	0.3604	0.2560

TABLE XVI-A. CORRELATION VALUES: X COORDINATE TO Y COORDINATE OF THE CONTACT POINTS IN POOLED SEXES OF CLASS I AND CLASS II, DIVISION 1 OCCLUSION

	CENTRAL	FIRST PREMOLAR	SECOND PREMOLAR	FIRST MOLAR	SECOND MOLAR	THIRD MOLAR
Class I (Males and females)	0.739	0.705	0.645	0.6012	0.5211	0.4049
Class II, Division 1 (Males and females)	0.563	0.573	0.416	0.5988	0.4866	0.3953

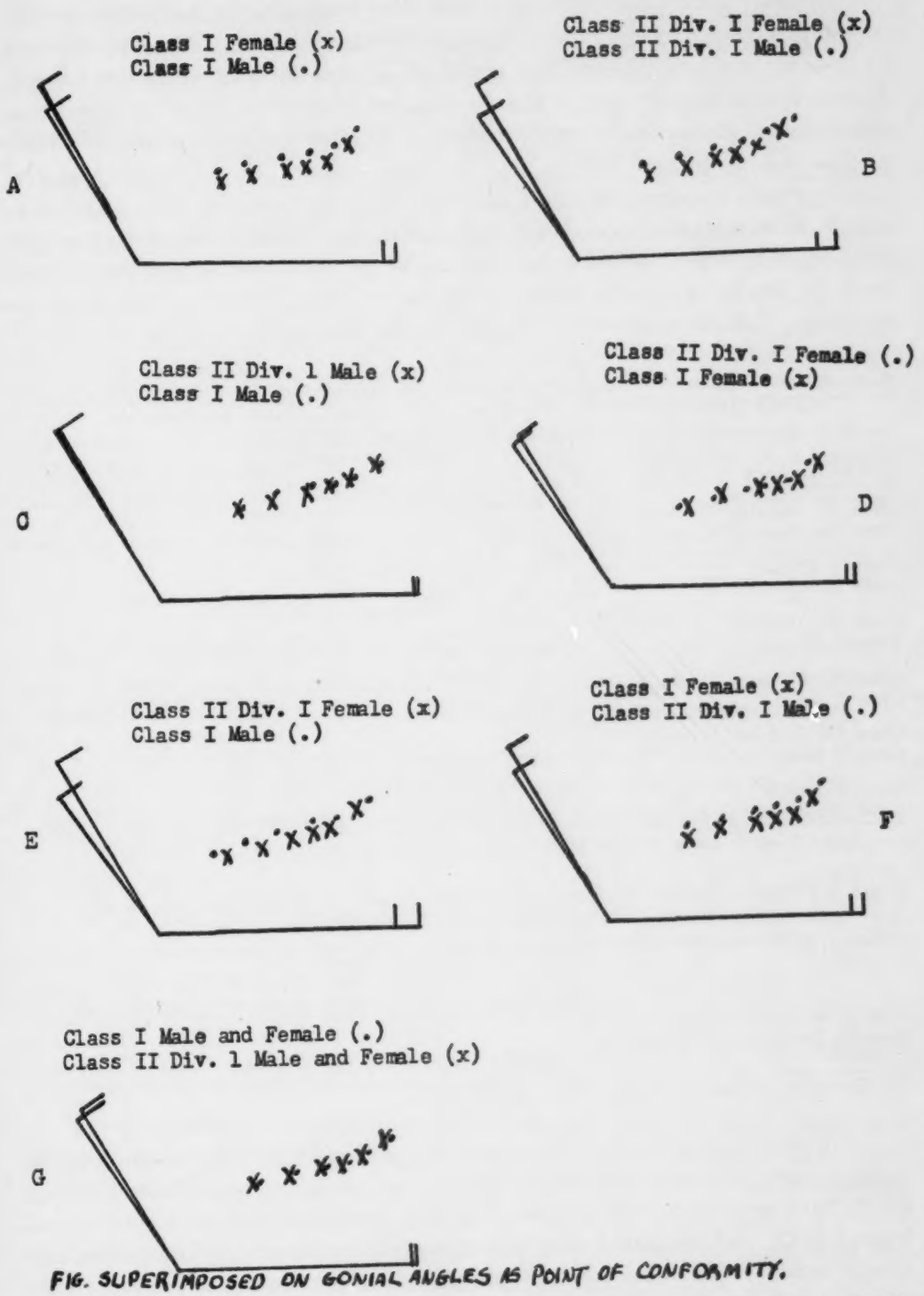
Class I Female (x)
Class I Male (.)
A
Class II Div. I Female (x)
Class II Div. I Male (.)
B
Class II Div. 1 Male (x)
Class I Male (.)
C
Class II Div. I Female (.)
Class I Female (x)
D
Class II Div. I Female (x)
Class I Male (.)
E
Class I Female (x)
Class II Div. I Male (.)
F
Class I Male and Female (.)
Class II Div. 1 Male and Female (x)
G
FIG. SUPERIMPOSED ON GONIAL ANGLES AS POINT OF CONFORMITY.

Fig. 4.—Composite of means derived from linear measurements made of the X and Y coordinates from the contact points on the curve of Spee.

Separate correlation coefficients were also computed for pooled-sex groups of the two classes to minimize variations due to sex alone. The general trend of these correlations (Tables XVI and XVI-A) was the same and more marked. It was then reasoned that if the correlations themselves were compared and found to be similar, this would indicate a further conformity of the curves of Spee for males and females, and for both classes. Accordingly, these correlations were compared by the t test. No class differences of significant magnitude were found (Tables XVII and XVII-A). This indicates that as the distance of the curve of Spee from the border of the mandible increases, it also tends to become greater relative to the ramus, and that this ratio shows no significant difference for either class or sex comparisons.

TABLE XVII. t SCORES OF VARIOUS INTERGROUP COMPARISONS OF THE CORRELATION X AND Y COORDINATES IN CLASS I AND CLASS II, DIVISION 1, MALES AND FEMALES

	CENTRAL	FIRST PRE-MOLAR	SECOND PRE-MOLAR	FIRST MOLAR	SECOND MOLAR	THIRD MOLAR
Class II, Division 1 female Class II, Division 1 male	1.776	1.635	2.967	2.647	2.974	2.508
Class I female Class I male	1.157	2.217	1.987	4.004	3.386	2.028
Class II, Division 1 female Class I female	0.218	0.20	0.176	0.038	0.073	0.080
Class II, Division 1 male Class I male	0.10	0.406	0.654	0.927	0.026	0.941
Class II, Division 1 female Class I male	2.20	2.260	2.041	3.431	3.022	1.909
Class I female Class II, Division 1 male	2.172	1.663	2.698	3.040	3.318	2.661

Refer to significance figures, Table II, No. 25.

TABLE XVII-A. t SCORES OF THE CORRELATIONS X AND Y COORDINATES IN CLASS I AND CLASS II, DIVISION 1, POOLED SEXES

	CENTRAL	FIRST PRE-MOLAR	SECOND PRE-MOLAR	FIRST MOLAR	SECOND MOLAR	THIRD MOLAR
Class I male and female Class II, Division 1 male and female	1.484	0.006	0.384	0.488	0.027	0.513

Refer to significance figures, Table II, No. 50.

3. *Comparison of results with those of other studies.* The results of this study do not tally with some earlier studies and beliefs. Both Elman[14, 15] and Blair[4] have previously derived the X and Y coordinate measurements of one contact point and compared these measurements by class. In both cases, the sample groups were under 18 years of age. (Blair's mean age was 12.5 years and Elman's sample range was 3 to 10 years.) For this reason, the actual measurements differed widely from the measurements listed here (see comparisons below). The Y/X ratios also differ in the three studies because of the

differential growth. No more exhaustive comparisons are available for the results of this study, since it is the first known study in which rigorous comparisons of the entire curve of Spee are attempted.

TABLE XVIII. COMPARISONS OF X AND Y MEASUREMENTS FOR BLAIR[4] AND THIS STUDY OF THE CONTACT POINT ON THE DISTAL OF THE FIRST MOLAR

CLASS	BRAUN AND SCHMIDT		BLAIR	
	X	Y	X	Y
Class I male	62.93	35.66	39.30	25.47
Class II, Division 1 male	60.87	34.58	40.30	25.6
Class I female	58.72	30.76	30.78	25.23
Class II, Division 1 female	57.47	30.09	38.21	24.19
Class I male and female	60.82	33.21	29.54	25.35
Class II, Division 1 male and female	59.17	32.34	29.25	24.92

TABLE XIX. COMPARISON OF X/Y RATIO

SAMPLE	CLASS I	CLASS II, DIVISION 1
Elman, 3 to 10 years	1-1.449	1-1.459
Blair, 12 years mean	1-1.56	1-1.161
Braun and Schmidt, 21 years mean	1-1.83	1-1.83

SUMMARY AND CONCLUDING STATEMENT

Summary.—This article is a controlled observation of 100 adult Caucasian subjects, equally divided between Class I and Class II, Division 1 occlusion, with males and females equal for each class. The questions asked were:

1. Do the certain clinical criteria which are frequently suggested as differentiating between Class I and Class II, Division 1 about ramus height, mandible length, gonial angle, and anterior skeletal pattern of the face actually differentiate between the two classes and/or between sexes?

2. Does this cephalometric investigation of the curve of Spee reveal differences in its characteristics between Class I and Class II, Division 1 and/or between sexes?

Briefly stated, the answers found in this study are:

1. *Clinical Criteria thought to differ in Class I and Class II, Division 1 (in addition to Angle's Classification) are:*

(a) The anterior skeletal facial pattern expressed by ANB angle and SN-AB angle were found to be significantly different between Class I and Class II, Division 1, with no differences between sexes. This proves that the sample as selected by Angle's classification was justified as being two different groups of the population. It indicates that all further problems analyzed from this material will be accurate for sample definition.

(b) Neither ramus height, gonial angle, nor mandible length were found to be different in size between Class I and Class II, Division 1 by t test analysis. Therefore, these measurements should not be used as a diagnostic aid for Class

II, Division 1. Tests were also made to determine the existence of possible relationships between the three factors (gonial angle, ramus height, and border length.)

1. No significant correlation was found to exist between any of the factors as to produce moment correlations or partial correlations.

2. The magnitude of the correlation was not significantly different between Class I and Class II, Division 1. Therefore, ramus height to border length, ramus height to gonial angle, or border length to gonial angle should not be used as a basis to differentiate between classes.

3. The study did uncover significant differences between male and female subjects. Ramus height and mandible length yielded significant differences in sex comparisons. The implications of both of these sets of findings bring up the question as to the possible genetic effect that might cause this difference to be greater than is expected between male and female as a sex difference or whether it could be caused by a hormone difference of males and females.

2. *With regard to the curves of Spee:*

(a) *Class comparisons of the curve of Spee.*

1. No significant differences were found between Class I and Class II, Division 1 either in the positions of the individual teeth (relative to the two borders) or in the shape of the curve of Spee. The curve of Spee, as here defined, was found to be identical for Class I and Class II, Division 1. Therefore, the suggestion that the incisors are supraerupted or premolars and molars are infraerupted to produce a different-shaped curve of Spee in Class II, Division 1 is not valid.

Correlations were computed to test the possible constant relationships between the locations of each contact point on the X-axis (contact point to ramus) and on the Y-axis (contact point to mandible border).

2. These correlations varied for the different contact points in all groups. Correlations are stronger at central incisors and weakest at third molars. The correlations of X and Y measurements for each tooth position were indicating that as the distance of the contact points from the border of the mandible increases, the distance from the contact point to the ramus also becomes greater for both Class I and Class II, Division 1, showing that there is a greater curve to the curve of Spee as it moves from posterior to anterior.

(b) *Sex comparisons of the curve of Spee.*

1. The shape of the curve of Spee for males and females tends to be identical.

2. The locations of the individual contact points (relative to the ramus and the mandibular border) showed significant differences between sexes for all points, indicating a difference of size of the curves of Spee, making the size of the curve of Spee smaller in females in all measurements.

3. The contact points on female curves of Spee were consistently closer to the borders. This is proof that females' X and Y coordinates are smaller than males', and gives definition to the smaller curve of Spee of the females.

Concluding Statement.—The results which this study yield, in the final analysis, are not merely a series of discrete conclusions. When we say that the ramus height, mandible lengths, and gonial angles are the same in Class I and Class II, Division 1, the meaning of the statement is greater than the sum of its unrelated parts, because mandible length, gonial angle, and ramus height are the significant dimensions of the mandible. When we have said that these dimensions do not differentiate between classes, we have exempted the entire structure of the mandible as a possible source of the differences between Class I and Class II, Division 1. When we can further assert that the average curve of Spee is the same in both classes, we also eliminate the curve of Spee as a source of difference between Class I and Class II, Division 1. In effect, we have reduced the possible sources of class variation to:

1. Difference in the actual structure of the maxilla.
2. Difference in the position of maxilla and mandible, relative to the cranial base.
3. Differences in the relative position of the maxilla related to its position to the curve of Spee.
4. Differences in relative positions of maxilla to mandible.

The finding of significant differences between classes in the frontal facial skeletal pattern confirms the latter three possibilities. The ANB angle and the SN-AB angle, which differed significantly in Class I and Class II, Division 1, define these three relations of position: (1) maxilla to mandible, (2) maxilla and mandible to cranial base, and (3) maxilla to curves of Spee. The curve of Spee and the mandible for the size, shape, and configurations, are identical for Class I and Class II, Division 1. There is a variable between sexes of the same class.

REFERENCES

1. Adams, J. W.: Cephalometric Studies on the Form of the Human Mandible, Angle Orthodontist **18**: 8, 1948.
2. Baldridge, J. P.: A Study of the Relation of the Maxillary 1st Permanent Molars to the Face in Class I and Class II, Division 1 Malocclusions, Angle Orthodontist **18**: 10-11, 1948.
3. Baldridge, J. P.: Further Studies of the Relation of the Maxillary 1st Permanent Molars to the Face in Class I and Class II, Division 1 Malocclusions, Angle Orthodontist **20**: 3-10, 1950.
4. Blair, E. S.: A Cephalometric Roentgenographic Appraisal of the Skeletal Morphology of Class I, Class II, Division 1, and Class II, Division 2 (Angle) Malocclusion, Angle Orthodontist **25**: 106-119, 1954.
5. Broadbent, B. H.: Ontogenic Development of Occlusion, Angle Orthodontist **11**: 223-251, 1941.
6. Broadbent, B. H.: Bolton Standards and Techniques in Orthodontic Practice, Angle Orthodontist **7**: 209-223, 1937.
7. Brodie, A. G.: Angle Concept of Class II, Division 1 Malocclusion, Angle Orthodontist **1**: 117-138, 1931.
8. Brodie, A. G.: Some Recent Observations on the Growth of the Face and Their Implications to the Orthodontist, AM. J. ORTHODONTICS AND ORAL SURG. **26**: 741-787, 1940.

9. Craig, C. E.: The Skeletal Patterns Characteristic of Class I and Class II, Division 1 Malocclusion in Norme Lateralis, Angle Orthodontist **21**: 44-56, 1951.
10. Carlson, H.: Studies on the Rate and Amount of Eruption of Certain Human Teeth, Angle Orthodontist **18**: 33-35, 1948.
11. Corlett, E. L.: Mandibular Incisor Position Relative to Basal Bone, AM. J. ORTHODONTICS AND ORAL SURG. **33**: 21-29, 1947.
12. Dewel, B. F.: Clinical Observation on Axial Inclination of Teeth, AM. J. ORTHODONTICS **35**: 98-115, 1949.
13. Drelich, R. C.: A Cephalometric Study of Untreated Class II, Division 1 Malocclusions, Angle Orthodontist **18**: 70-76, 1948.
14. Elman, E. S.: Studies on the Relation of the Lower 6 Year Molar to the Mandible, Angle Orthodontist **10**: 24-32, 1940.
15. Elman, E. S.: Further Studies on the Relation of the Lower 6 Year Molar to the Mandible, Angle Orthodontist **18**: 9, 1948.
16. Elsasser, W. A., and Wylie, W. L.: The Craniofacial Morphology of Mandibular Retrusion, Am. J. Phys. Anthropol. **6**: 461-474, 1948.
17. Furstman, L.: Cephalometric Appraisals: Their Use in Daily Clinical Practice, AM. J. ORTHODONTICS **36**: 403-417, 1950.
18. Fisk, G. V., Culbert, M. R., Grainger, R. M., Hemrend, B., and Moyers, R.: The Morphology and Physiology of Distoclusion, AM. J. ORTHODONTICS **39**: 3-11, 1953.
19. Gilmore, W. A.: Morphology of Adult Mandible in Class II, Division 1 Malocclusion and in Excellent Occlusion, Angle Orthodontist **20**: 137-146, 1950.
20. Margolis, H. I.: Standardized X-ray Cephalographics, AM. J. ORTHODONTICS AND ORAL SURG. **26**: 725-740, 1940.
21. Margolis, H. I.: The Axial Inclination of Mandibular Incisors, AM. J. ORTHODONTICS AND ORAL SURG. **29**: 571-594, 1943.
22. Markus, M. B.: A Study of the Lower Angular Relationship in Upper and Lower Teeth, AM. J. ORTHODONTICS **36**: 281-291, 1950.
23. Nelson, W. E., and Higley, L. B.: The Length of the Mandibular Basal Bone in Normal Occlusion and Class I Malocclusion Compared to Class II, Division 1 Malocclusion, AM. J. ORTHODONTICS **34**: 610-617, 1948.
24. Frakash, P., and Margolis, H. I.: Dento-Craniofacial Relations in Varying Degrees of Overbite, AM. J. ORTHODONTICS **38**: 657-673, 1952.
25. Renfroe, E. W.: A Study of Facial Patterns Associated With Class I, Class II, Division 1, and Class II, Division 2 Malocclusions, Angle Orthodontist **18**: 12-15, 1948.
26. Richetts, M. R.: A Study of Changes in the Temporomandibular Relations Associated With the Treatment of Class II, Division 1 Malocclusions, AM. J. ORTHODONTICS **38**: 918-933, 1952.
27. Speidel, T. D., and Stoner, M. M.: Variation of the Mandibular Incisor Axis in Adult "Normal" Occlusion, AM. J. ORTHODONTICS AND ORAL SURG. **30**: 536-542, 1944.
28. Wylie, W. L.: The Relationship Between Ramus Height, Dental Height and Overbite, AM. J. ORTHODONTICS AND ORAL SURG. **32**: 57-67, 1946.

THE ROLE OF ORAL SURGERY IN ORTHODONTIC TREATMENT PLANNING

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IN DISCUSSING the surgical phases of orthodontic treatment, we should keep in mind that the main object of such treatment has been, first, to increase the efficiency of the dental apparatus as an organ of mastication and, second, to improve the appearance of the human face.

Prior to the time of John Hunter little was published regarding the reasons for the crude treatment of dental disease but, since then, sufficient evidence has been accumulated to show that oral surgical procedures are a necessary adjunct to the successful definitive treatment of the majority of cases which are seen by practitioners in the allied dental specialties. Again referring to John Hunter, we find that in his work, Natural History of Human Teeth, he states: "To extract an irregular tooth would answer but little purpose if no alteration could be made in the situation of the rest; but we find that the very principle upon which teeth are made to grow irregularly is capable, if properly directed, of bringing them even again; this principle is the power which many parts have of moving out of the way of mechanical pressure." I could go on at length quoting from papers written by pioneers in dentistry who were enthusiastic in their theories relative to surgical interference in the correction of deformities of the masticating apparatus and its adjacent soft tissues. Briefly, however, a résumé of the last 170 years of orthodontic history shows that, with the exception of Angle and Davenport, the feeling of the leaders in the profession was that oral surgery, as surgery in any other part of the body, was not to be avoided if the exigencies of the individual case demanded it and no other method of correction was sufficient in itself to complete the case successfully.

We are dentists, guardians of the human masticating mechanism. Out of the very large group classified as dental practitioners, we have allied ourselves together under the specialties of oral surgery and orthodontia. As such, we have children placed in our care for advice and treatment regarding their dental problems. To evaluate properly the immediate surgical needs relative to orthodontic treatment, the oral surgeon must be fully informed of the treatment and prognosis of the case. This necessitates close cooperation between the oral surgeon and the orthodontist—a trite phrase, but one of which we must be more and more conscious with the present-day concept of orthodontic treatment.

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Allow me to repeat, in my own words, some of the thoughts of Charles H. Tweed of Tuscon, Arizona. Over ten years ago he was making some of these observations, based on clinical evidence.

He had four orthodontic objectives: (1) stability of end result, teeth that remain in corrected position; (2) healthy investing tissues insuring longevity of denture; (3) a dental apparatus that can work efficiently; and (4) the best in facial esthetics. In spite of these high objectives, when, after six and one-half years in orthodontic practice, he examined 70 per cent of cases treated, 20 per cent were termed successes and 80 per cent were termed failures. Investigations in other orthodontic practices produced similar startling figures.

This is not the time or place to attempt a course in the proper treatment of malocclusions, but we should refresh our minds on some of the principles that we were taught as dental students concerning the position of teeth upon the dental ridge.

Orthodontists of the past who have believed in the philosophy of the full complement of teeth have presumed that they could create normal occlusion for any patient who came to them. They were also assuming that the base bones would continue to grow forward following orthodontic treatment and eventually accommodate all teeth in normal relationship and provide good facial esthetics. This assumption, we know now, is a fallacy, recognized by a majority of the orthodontic specialists. Briefly, then, to summarize the previously made statements, it has been found that to attain the real objectives of orthodontic therapy that it is necessary to remove dental units surgically in addition to the repositioning of other units. It has been found that the removal of the four first premolars has been the most successful; however, it has been my experience that each individual case must be evaluated on its own merits. In those cases which require extraction of dental units, there are variables to be determined by a close study of roentgenographic evidence and clinical examination. Even then, however, there will still be cases lying on the border line, and only compromise action on the part of the orthodontist and oral surgeon can place them in the realm of cases successfully treated.

To aid in the accomplishment of the previously named objectives, then, the orthodontist has called upon the oral surgeon in certain selected cases.

Oral surgical procedures utilized in orthodontic treatment are as follows:

1. Excision of the abnormal labial frenum
2. Extraction of ankylosed deciduous teeth
3. Extraction of supernumerary teeth
4. Extraction of malposed teeth
5. Removal of hypertrophic tissue overlying teeth delayed in eruption
6. Exposure of delayed erupting teeth by osseous removal
7. Repositioning of malposed unerupted teeth
8. Extraction of dental units

A. Bicuspids

B. Third molars

9. Surgical correction of prognathic mandibles

Now let us elaborate on each of the foregoing.

The Abnormal Labial Frenum.—In order to discuss the abnormal, we must first have a clear understanding of what is considered normal.

We learn from competent anatomists that, in the embryo, the superior labial frenum begins to take form within the first few months of fetal life. It begins as a slight elevation on the inner surface of the upper lip at about the same time as the anterior palatine papilla forms. A continuous band of tissue, known as the tectolabial frenum, now connects these two points. This band of tissue often appears, in the young infant, to be abnormally large; as development takes place in the maxilla, however, normally this band of tissue is separated to form a palatal and a labial portion, the latter being the superior labial frenum.

What, then, determines whether or not this same frenum is to be termed abnormal? What appears to be an abnormal hypertrophied frenum in a child may gradually change character with the eruption of teeth and development of the premaxilla and become a normal-appearing and functioning frenum. A frenum, however, that retains the characteristics of the embryonic fold of tissue or tectolabial frenum, with a broad base of attachment in the lip extending palatally to be inserted into the palatine papilla, with a resultant diastema, may be termed abnormal. The excision of such a frenum can be a cosmetic as well as an orthodontic aid in the treatment of such cases. The excision of the abnormal superior labial frenum should be considered as an oral plastic procedure and not as just the removal of a mechanical obstruction to a diastema. I prefer to consider the operation as a partial excision of the frenum and a reattachment of the normal musculature. To accomplish this end result, a V-shaped incision is made on either side of the palatal portion of the frenum, with the apex at the incisive papilla. This portion of the frenum is now dissected free and is grasped with a hemostat. A similar type cut is made from the lip portion, completing the excision. The lateral sides of the wound are undermined and coapted sufficiently to be sutured without tension. Non-absorbable sutures are used in order that the wound may have sufficient time to granulate. It has been my experience that absorbable sutures are lost too early, with a resultant wide deformity in the wound and increased cicatricial tissue over the remaining frenum attachment. Some mention should be made of the lower labial frenum and the so-called "runners" which extend from the gingival margin of the incisors to the mucobuccal attachment of the lower lip. It is seldom that we see a typical abnormal inferior labial frenum as it compares to the superior, but we frequently observe an inferior labial frenum which attaches itself at the crest of the interdental papilla and has one or two supplementary "runners" on either side. This abnormal condition, combined with the muscular action of the lower lip, tends to pull the gingival tissue from the necks of the adjacent incisors. This results in a chronic gingivitis in this area,

with the gradual diminishing of the labial alveolar bone. As you may note, I have not entered into a discussion of the controversy as to when, or if, frenectomies should be done. I believe that each individual case must be evaluated and the decision to do or not to do must rest with the oral surgeon and the orthodontist, together.

Ankylosed Teeth.—It is, I believe, the routine practice of orthodontists, before the initiation of orthodontic treatment, to have a complete roentgenographic survey made of the patient's dental mechanism. At this time the probability of delayed eruption of permanent teeth, the presence of supernumerary teeth, and other abnormalities of the dental structures should be determined as closely as possible. The degree of eruption of the permanent teeth and the progress of resorption of the roots of the primary teeth should be carefully noted. When primary teeth, particularly the molars, are not exfoliated at the normal time, their retention will complicate the normal erupting period of their permanent successors. These primary teeth appear to become "submerged" below the separate identity as tooth structure, with resultant ankylosis to the alveolar bone. The removal of such teeth becomes a procedure which requires delicate handling of soft tissue, as well as careful dissection in the alveolar bone. Ankylosed primary teeth are noted more commonly when the permanent successor is congenitally absent. I make note of the fact here, however, that the mere fact that a permanent successor is not seen in roentgenographic examination directly inferior to the primary tooth is no assurance that it will not be found in some other portion of the dental arch at a later date. It is not unusual to find an adult with a retained primary tooth and the permanent successor migrated to a position far from its normal one.

Supernumerary Teeth.—One of the most common anomalies in the dental arches is the presence of supernumerary teeth. They are found most frequently in the anterior portion of the maxillary arch and in the premolar areas of the mandibular arch. Their presence may result in impaction of permanent teeth, ectopic eruption, or (as is usually seen in the midline of the maxillary dentition), a diastema of the adjacent incisors. The tardy eruption of permanent teeth should be reason for adequate roentgenographic examination to determine the causative factor. The time for removal of a supernumerary tooth is a variable one, depending on the age of the patient, the position of the tooth in relation to adjacent structures, and its importance, if retained, to the orthodontic treatment planning.

Excision of Hypertrophic Tissue.—Frequently cases are seen in which there is a delayed eruption of permanent teeth. Roentgenographic examination will determine that, in many of these, the individual tooth is in a vertical position in the arch, the spacing is normal, and there is no osseous obstruction. Close examination will reveal a thickened overlying gingival crest which has prevented the normal eruption of the tooth. Excision of this tissue will allow the speedy eruption of the tooth into its normal position.

Exposure of Teeth.—The premature loss of primary teeth influences, to a large extent, the delayed eruption of permanent successors. If the primary

tooth is lost before root resorption is well under way, there is a rapid healing of the alveolar socket which delays the erupting process. Frequently there is no attempt to maintain space, with the resultant drifting of adjacent teeth. When space has been made to accommodate the tooth in question, it is found to have a thick covering of alveolar bone. Exposure of this area, removal of the overlying bone with surgical burs, and the placing of a medicated dressing to prevent early healing will facilitate the eruption of the tooth. Particular mention should be made here of the delayed erupting maxillary cuspid. Probably this tooth, more than any other, is a problem to the orthodontist and oral surgeon alike. Because of its importance in the dental arch, it is not sacrificed without careful consideration. In the delayed eruption state, the more common and most troublesome position in which to find this tooth is one the palatal surface with the tip of the crown lying in close proximity to the lateral or central incisor root with the apex of the root in a position near the first premolar. There are many variations of this, depending on individual characteristics. In the past, to expose a tooth as described, a section of palatal tissue was excised, overlying bone was removed, and the cavity was packed long enough to insure delayed healing. Many of these cases would respond rapidly, while others would need to be opened repeatedly until the crown of the tooth was exposed sufficiently to be aided into its proper position. Recently, to prevent the formation of scar tissue in the palate over the unerupted tooth, I have been retracting a mucoperiosteal flap from the gingival margin and exposing the crown of the tooth by removal of overlying bone. A bony channel is then cut extending into the normal alveolar socket, and the soft tissues are sutured. If this is done at the opportune time, I believe such a procedure facilitates the eruption of this tooth to a point where, later, a small excised area of soft tissue will immediately expose the tooth near its normal position. Variations, however, in the malposition of this unerupted tooth make each case an individual problem and many times the procedure, from an oral surgical and orthodontic standpoint, must be changed as the case progresses.

Repositioning of Malposed Unerupted Teeth.—Some time ago, while in a hospital operating room, I was summoned to an adjacent room to advise on a slight accident. The operator, while performing a tonsillectomy, had inadvertently dislodged a primary second molar and with it, the second premolar from its crypt. The area was quickly suctioned, the premolar was replaced, and the soft tissues were sutured in place. I had the opportunity to follow this case for approximately two years and observed the development of this tooth into a normal functioning unit. The thought then occurred, "Why could not a similar procedure be accomplished with malposed unerupted teeth?" We now have several cases under observation following surgery. Briefly, the technique is as follows: The primary tooth is extracted and bone overlying the crown of the permanent tooth is removed with a surgical drill. Bone lateral to the tooth is now removed to the extent necessary to bring the tooth into a vertical position. The tooth may be rotated if necessary. A strip of absorbable cellulose is compressed and packed into the space created, thus making a matrix for a blood clot and beginning fibrous tissue. There is no labial or lingual bone removed

except within the alveolar walls. The soft tissues are closed without tension. This operation with a palatal cuspid has been reported by several operators, with successful results.

Malposed Teeth.—Individual cases may have one or more malposed teeth which, when removed, will lessen the orthodontic problem at hand. Such a practice, however, if not under orthodontic control, is fraught with many dangers. The general practitioner of dentistry has a misconception of orthodontic treatment when he adopts the extraction of malposed teeth as the sole method for the elimination of malocclusion. Salzmann,[8] in 1943, in a series of studies dealing with the shifting of teeth after extraction when not followed by orthodontic control, reported: "Extraction per se cannot be relied upon to correct crowding of teeth nor can extraction be resorted to successfully as the sole means for the elimination of malocclusion as it manifests itself in the various classifications established by Angle. In those cases which showed improved occlusion after extraction, such improvement was purely accidental and the result of other favorable conditions present in the mouth which did not permit the usual promiscuous shifting of the remaining teeth in the dental arches but guided them instead into a favorable relationship."

Extraction of Dental Units.—As an oral surgeon, I am not here today to discuss the rationale of the extraction of dental units as a procedure associated with the treatment of malocclusion. You, as orthodontists, have your essential objectives to orthodontic treatment. For years your profession has been treating cases of malocclusion with firmly established convictions on the methods of treatment and prognosis of each individual case. It took the courage of Charles H. Tweed of Tuscon, Arizona, to revive the practice of reducing the number of dental units in the arches in order that the remaining teeth might be rearranged to positions wherein they were properly supported by undergrown bony bases. I will not dwell further on the orthodontic concepts of this treatment. I do, however, wish to mention certain fundamental surgical principles with which the orthodontist should be familar in order that he may determine more adequately the surgical prognosis of his case.

We must realize that dentists coming from different schools and teaching institutions have been trained in varied surgical techniques. No attempt should be made to change that individual technique as long as it is based on a sound framework which embodies proper diagnosis, an adequate armamentarium, and a series of steps for the operative procedure. The term *diagnosis* must be applied to both clinical and roentgenographic diagnosis, and the two must be considered simultaneously in order to evaluate the case properly. The physical condition, age, and temperament of the patient and the amount of surgery to be performed will determine the anesthetic agent to be used.

Adequate roentgenographs means that the area to be operated upon shall have been viewed from all angles, with varied supplementary films if necessary.

The dentist should have instruments available and in a proper condition that he may carry out his surgical procedure with dispatch and skill.

There are five definite steps in the order of procedure for the surgical removal of a dental unit. They are as follows:

1. Access to the operative site
2. Removal of osseous obstruction
3. Removal of the tooth
4. Débridement of the wound
5. Closure of the wound

Many failures in uncomplicated procedures have occurred because these few simple rules were not adhered to.

In the past fifteen years much has been written concerning the lower third molar problem, particularly as it relates to pre- or postorthodontic treatment. However, we can go back much farther than fifteen years to find numerous articles concerning the same problem.

The first dental book in English, published in Dublin in 1686 by Charles Allen, was called *The Operator for the Teeth.* In this, Allen describes the eruption of the permanent molars and points out that "the four last of them seldom coming out before the one or two and twentieth of age, for which reason are called, teeth of wisdom, because by that time we should have a full use of our rational faculty, though God knows how often it proves to be true."

He expresses his views on the reason for impacted third molars as follows:

1. "The gums are more sinewy and membranous about them than anywhere else, and therefore much more difficult to penetrate."
2. "That part of the jaw-bone that contains them is likewise much thicker and stronger than any other, consequently harder to divide by the included teeth."

(Not much different from today, almost 300 years later.) Allen goes on to explain how he believes these teeth are finally erupted. "Nature having perfected our growth, the blood becomes hotter, stronger and its energy more powerful by the firmness of the heart, being able to surmount the resistance of the jaw and gums, forces the said teeth to come out of their cells and grow up."

Incidentally, he describes a very unusual technique for the removal of these teeth. It consists of the use of a suction syringe applied to the gum overlying the third molar. The gingival tissue was sucked up into the cuplike opening of the instrument, after having been prepared with "emollients and relaxing things," and kept there for a time. Then this piece of tissue was cut away and the suction repeated twice daily for two weeks. "By this means, with the gums yielding, the force of the blood compelled the fibres of the tooth to advance according to their natural order and so cause the tooth to grow." This technique is not far removed from today's exposure technique for unerupted premolars and cuspids.

Interest today, however, has become more or less centered on the symptoms and complex disturbances which are caused by the erupting third molar, or by its partial or complete impaction. Techniques and instrumentation for the removal of this tooth are of individual preference.

Oral surgeons and orthodontists are interested in the problem from the viewpoint of the disturbances to the general health of the patient, its effect upon the normal dentition, its attributing factor to a malocclusion, or from the viewpoint of preventing its impaction by correcting an underdeveloped mandible or maxilla. It was not too far in the past that some of us sincerely believed that nothing would be lost if systematically all third molars were removed as early as possible and the patient thus spared the many unpleasant and annoying symptoms that might occur through the development and eruption of partial and complete impaction of these teeth. We know now, however, through such work as done by Broadbent and Hellman, that third molars do play an important role in facial and jaw development and, therefore, we must assume that, unless we can show cause by overmesial inclination of these teeth or positive lack of development and growth in the ramus of the mandible, the extraction of these teeth should be delayed. The eruption of mandibular third molars is based on four factors:

1. The development and growth of the mandible
2. The development and growth of the crown portion of the tooth
3. The change in the inclination of the crown
4. A sequential, interrelated growth of all factors and phenomena involved

My firm belief is that each case must be judged individually on these foregoing factors. The orthodontist and the oral surgeon have a definite duty to perform when young patients are placed in their hands for advice and treatment regarding their teeth. It is a duty which not only includes immediate needs but should consider future conditions. Can we say that this duty has been well performed if it should be necessary for the patient, on reaching a more mature age, to undergo a complicated and difficult surgical operation for the removal of impacted wisdom teeth? Our aim in dentistry is prevention of decay, of periodontal infections, of the early loss of teeth, and of other dental disturbances. Scientific advances at our disposal give us the opportunity to discover forces and factors which may tend to cause or influence these disturbances at an early age. Here is our chance, then, to guide these aberrant forces back to their normal path or to intervene surgically in the prevention of a more complicated human masticating mechanism.

Where extraction of teeth in orthodontic treatment is indicated, it should be done with extreme skill and dispatch, but allow me to close with this quotation from de le Barre in 1815: "It is easier to extract teeth than to determine whether it is absolutely necessary. The extraction of a tooth requires nothing more, on the part of the practitioner, than a degree of facility in the use of instruments that are usually employed in the operation; whilst the knowledge necessary to appreciate the consequences can only be acquired by time and study."

REFERENCES

1. Angle, Edward H.: Malocclusion of the Teeth, ed. 7, Philadelphia, 1907, S. S. White Dental Mfg. Co.

2. Broadbent, B. H.: A New X-ray Technique and Its Application to Orthodontia, Angle Orthodontist **1**: 45, 1931.
3. Brodie, A. G., Downs, W. B., Goldstein, A., and Myer, E.: Cephalometric Appraisal of Orthodontic Results, Angle Orthodontist **8**: 3, 1938.
4. Brodie, A. G.: Some Recent Observations on the Growth of the Face and Their Implications to the Orthodontist, AM. J. ORTHODONTICS AND ORAL SURG. **26**: 741, 1940.
5. Fischer, Bercu: Retention: A Discussion of Permanency of Results in Orthodontic Practice, AM. J. ORTHODONTICS AND ORAL SURG. **29**: 5, 1943.
6. Greenstein, A. V.: The Tweed Philosophy, AM. J. ORTHODONTICS AND ORAL SURG. **29**: 527, 1942.
7. Johnson, A. Leroy: The Individual Normal Occlusion, University of Pennsylvania Lectures.
8. Salzmann, J. A.: Principles of Orthodontics, Philadelphia, 1943, J. B. Lippincott Company.
9. Tweed, Charles H.: The Application of the Principles of the Edgewise Arch in the Treatment of Malocclusion, Angle Orthodontist **11**: 5-11, 12-67, 1941.
10. Hellman, Milo: Development of Face and Dentition in Its Application to Orthodontic Treatment, AM. J. ORTHODONTICS AND ORAL SURG. **26**: 424, 1940.
11. Margolis, H. I.: Axial Inclination of Mandibular Incisors, AM. J. ORTHODONTICS AND ORAL SURG. **29**: 571, 1943.

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RELATIONSHIP OF THE MAXILLARY FIRST PERMANENT MOLAR IN NORMAL OCCLUSION AND MALOCCLUSION

An Intraoral Study

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INCLINED PLANE RELATIONSHIP

THE normal inclined plane relationship of the maxillary first permanent molar has been described by nearly every author of an orthodontic textbook. Angle,[1] who first drew attention to this relationship, originally described it as follows: "The mesial incline of the mesio-buccal cusp of the upper first permanent molar occludes with the distal incline of the mesio-buccal cusp of the lower first molar; the distal incline of the mesio-buccal cusp of the upper first permanent molar occludes with the mesial incline of the disto-buccal cusp of the lower first molar; the mesial incline of the disto-buccal cusp of the upper first molar occludes with the distal incline of the disto-buccal cusp of the lower first molar and the distal incline of the upper first molar occludes with the mesial incline of the lower second molar."

Stoller[2] corrected the misconception that the mesio-buccal cusp of the upper first molar occludes in the buccal groove of the lower first molar in normal occlusion when viewed buccally. He wrote, "The position of the maxillary first molar in normal occlusion was noted to be such that its mesio-buccal cusp occluded distally to the buccal groove of the mandibular first molar."

There is still the tendency to disregard the position of the mesio-lingual cusp of the upper first molar, and years ago Hellman[3] gave special emphasis to this cusp when he said, "It must be emphasized that these are the only reliable distinguishing features because they are the most primitive landmarks of occlusion still retained in the dentition of man."

Strang[4] adds, "From a mechanical standpoint it would naturally follow that the mesio-lingual cusp of the upper first molar would be the last cusp to lose its proper relationship owing to the fact that it is surrounded by the four cusps of the occluding tooth, so that every one of its inclined planes is under the influence of an opposing force, whereas the other cusps of this molar are governed by only two inclines each."

AXIAL RELATIONSHIP

1. *Sagittal Plane.*—Hemley[5] says, "It is the interlocking character of occlusion as a result of the inclined plane morphology of the teeth which directly

determines the axial inclination in any given instance. In normal occlusion the upper first permanent molars have a mesial axial inclination as do all the other posterior teeth—upper and lower. The condyles being on a higher level than the plane of occlusion means that on closure the mandible moves forwards and upwards. This forward movement and the mesial axial inclination of the teeth produce what is called 'The Anterior Force Component.' ''

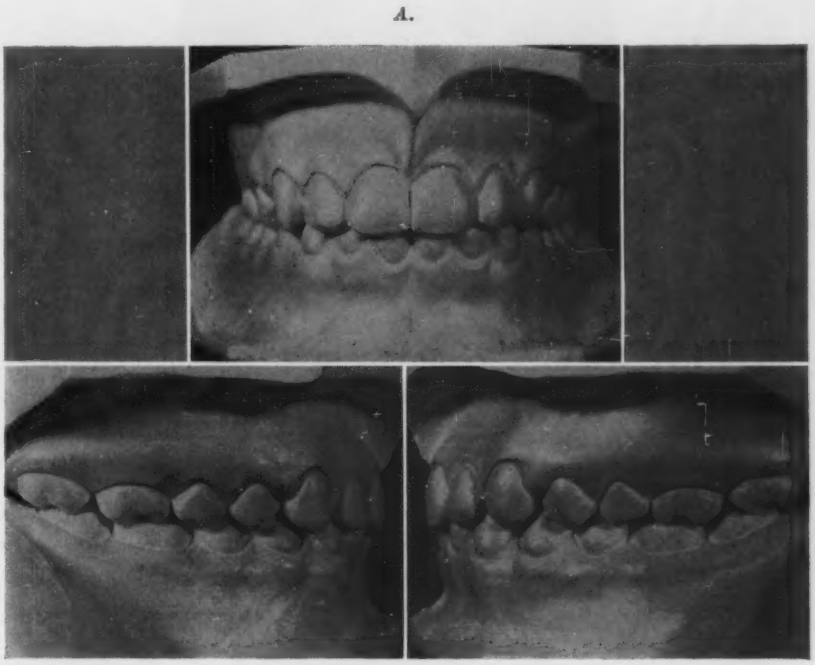


Fig. 1.—Normal occlusion.

Fig. 2.—Normal axial relationship of the upper first molar (sagittal plane).

In Stoller's[6] study of the upper first molar, he recorded its axial relationship in normal occlusion by drawing a line touching the tips of the buccal cusps. This line, when extended, passed through the crown of the upper canine tooth. This method of study has been utilized here in relation to cases of malocclusion.

2. *Occlusal Plane (Rotation).*—"The molars adhere to the primitive manner of aligning themselves in the dental arch. The mesio distal axis obliquely set to the outline of the dental arch," states Hellman.[7] In another way, Strang[8] says, "The buccal ridge of the mesio-buccal lobe of the first molar stands out so far buccally that it gives the arch form a distinct offset buccally as it passes from the second premolar to the first molar area."

Fig. 3.—Normal axial relationship of the upper first molar (occlusal plane).

MESIAL DRIFT

Angle[9] was adamant regarding the mesial movement of the upper first molar.

"(a) The upper first permanent molar varies considerably mesially and distally in different facial types.

"(b) It may vary in each side in the same individual—this is in keeping with nature.

"(c) It may vary in freaks.

"(d) The variation may result from mutilation. This, however, can easily be detected and allowances made.

"BUT the author has been unable to find a single case in an unmutilated denture where it would seem that nature had erred in not locating these most important teeth so as to be in best keeping with the remaining typal anatomic factors.

"If the upper first molar moves forward into the space of a deciduous second molar, it does precisely, though prematurely, what it would do and must do ultimately in the growth of the jaws. I have never seen a case where the upper first molar had been made to travel mesially to its final normal position."

Because of the anterior force component, there is a constant mesial force upon the molars. "Of all the buccal teeth those most posterior swing into occlusion on arcs of the greatest curvature. They receive the maximum amount of force by reason of position, size and function; hence molars have the greatest tendency to move forward at every opportunity afforded them," says Stallard.[10]

Molars may move forward in various ways—tipping, rotation, bodily, or any combination of these.

Hemley[11] claims, "The more recent studies of bone growth have substantiated Angle's observation that when teeth deviate from their normal positions into malocclusion it is by tipping, except when the tooth bud itself is displaced. In other words, teeth do not migrate horizontally through bone throughout the entire length of the tooth; they tip in response to some force created by occlusion or habit."

Dewel,[12] however, disagrees and declares, "These mesially displaced upper teeth, moreover, will not usually show the degree of mesial tipping that occurs in the lower arch; they tend to move forward bodily more than do the lower teeth. . . ."

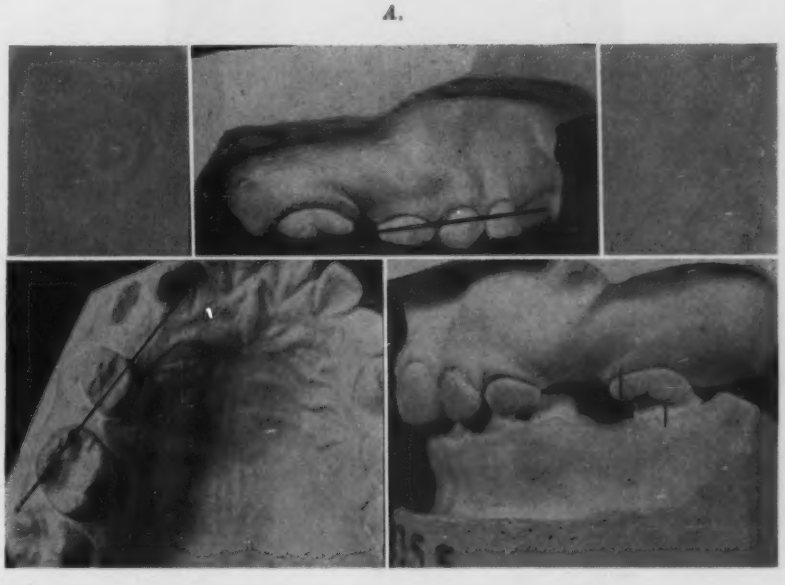


Fig. 4.—Upper first permanent molars, tipped, rotated, and bodily forward.

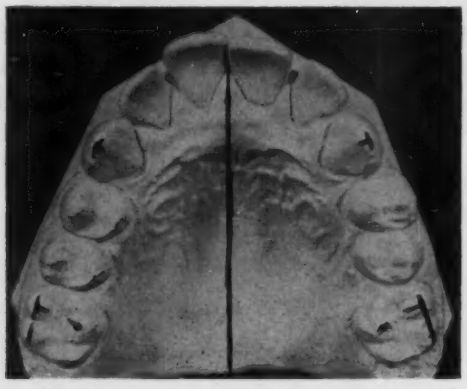
Swinehart,[13] studying the relationship of thumb-sucking to malocclusion, found that of the twelve cases of Class II, Division 1 the mesiodistal malocclusion of the buccal teeth occurred on the same side as the thumb pressure. This would seem to indicate a forward movement of the buccal teeth on the affected side.

Strang[14] asserts that a perverted swallowing habit can cause a mesial tipping of the buccal teeth. "This mesial tooth tipping is produced by pressure from behind by the forward-propelling muscles, by the excessive lingual pressure of the buccinator muscles, from which the teeth try to escape in the only ways that they can, which is by moving lingually and sliding forward."

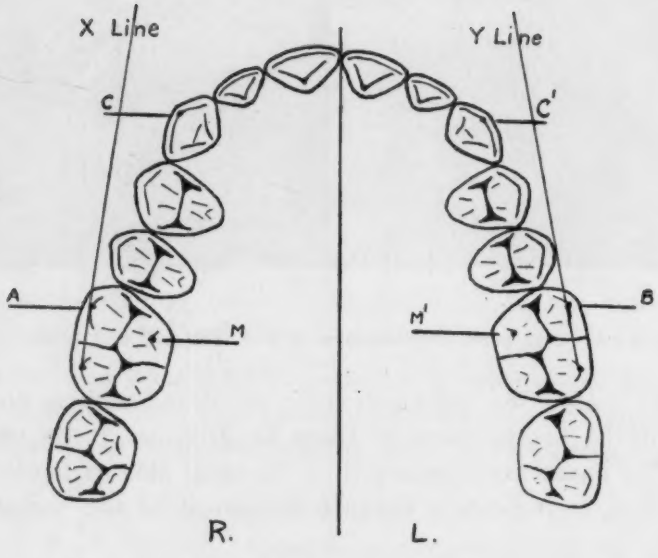
Fischer[15] seems to agree with Johnson, Young, Smyth, and Still[16] that approximately two-thirds of the Class II, Division 1 malocclusions are actually maxillary protrusions, that is, the upper first permanent molars are mesial to normal.

AIM OF THE SURVEY

The purpose of the survey reported in this article was (1) to study the position of the upper first permanent molar within the dental arch in normal occlusion; (2) to discover what changes may occur in its position in cases of malocclusion; and (3) to assess the importance and implication of these changes.



A.



B.

Fig. 5.—Reference points and lines.

MATERIAL

All measurements were obtained from dental plaster casts of the following:

1. Twenty cases exhibiting excellent (normal) occlusion.
2. Twenty-five cases of Class I malocclusion which required the extraction of four premolars in treatment.
3. Thirty cases of Class II, Division 1 malocclusion.

4. Twenty cases of Class II, Division 1 subdivision malocclusion.
5. Twenty cases of Class II, Division 2 malocclusion.

These cases of malocclusion were specifically chosen because it was considered possible that forward movement of the upper first permanent molars may have occurred in some or all of these cases. The individual cases, however, were picked at random.

REFERENCE POINTS AND LINES (FIG. 5)

C and C′: The incisal tips of the upper right and left canines, respectively.

M and M′: The tips of the mesiolingual cusps of the upper first permanent molars, right and left, respectively.

A and B: The tips of the mesiobuccal cusps of the upper first permanent molars, right and left, respectively.

X and Y: The lines passing through the tips of the buccal cusps of the upper right and left first permanent molars, respectively.

Median raphe.

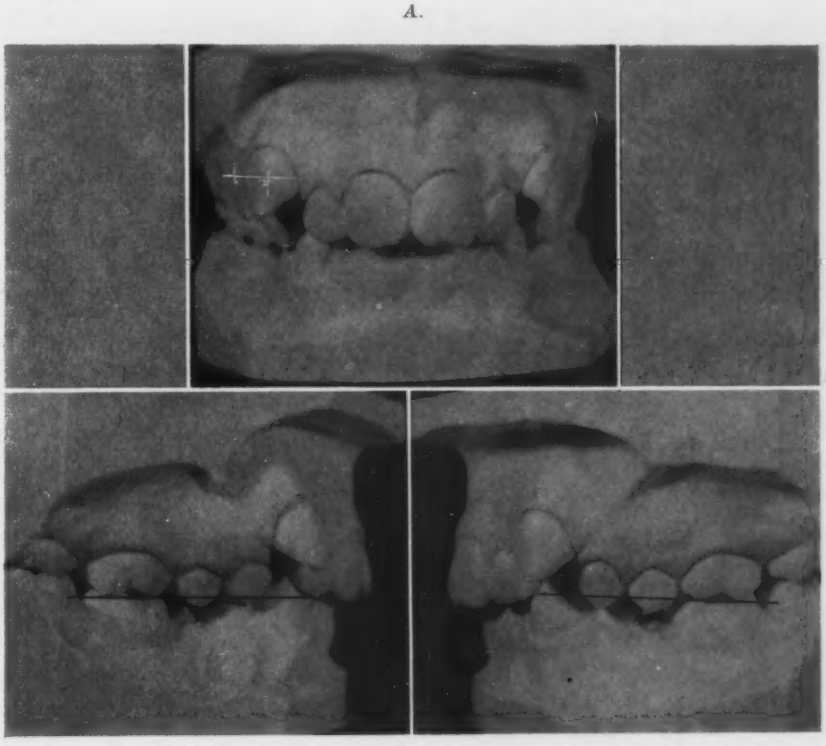


Fig. 6.—Malposition of canines.

MEASUREMENTS

1. *Denture Pattern.—*

M-M′: The distance, in millimeters, between the upper first permanent molars.

C-C′: The distance, in millimeters, between the upper canines.

TABLE I. NORMAL

PATIENT	RIGHT					LEFT							
	M FORWARD (MM.)	M ANGLE (DEGREES)	M-A (MM.)	X-C (MM.)	CANINE (MM.)	M′ FORWARD (MM.)	M′ ANGLE (DEGREES)	M′-B (MM.)	Y-C′ (MM.)	CANINE (MM.)	M-C (MM.)	M-M′ (MM.)	C-C′ (MM.)
1		5.0	3.0	9.0	1.0		7.8	3.0	8.0	1.0	24.0	48.5	35.0
2		7.5	3.0	6.0	−1.0		6.0	2.8	7.5	1.0	24.5	40.0	34.5
3	1.0	14.7	3.0	2.5	0.0		14.7	2.8	2.5	0.0	23.5	40.0	33.5
4		15.5	2.5	1.0	2.5		15.5	2.5	1.0	1.0	24.0	34.5	34.0
5		13.3	3.5	1.0	2.5		15.8	4.0	1.0	2.5	25.4	40.0	36.8
6		8.0	2.5	4.5	1.0	2.0	14.0	2.5	2.5	0.0	23.2	38.8	33.0
7		3.3	3.5	7.5	1.0		9.0	3.5	5.5	1.0	23.5	40.0	33.0
8		9.2	3.5	3.5	−1.0		14.2	3.5	4.7	1.0	25.0	40.0	35.0
9		13.5	3.0	4.5	2.0		2.5	3.0	7.5	1.5	26.0	42.0	34.0
10		11.5	2.5	3.0	3.5	0.5	10.0	2.5	3.5	3.0	24.0	42.0	37.5
11		8.0	3.0	7.5	−1.0	1.0	13.0	3.2	5.0	2.0	23.0	42.5	34.0
12		7.5	3.2	7.0	1.0	1.5	6.0	2.5	8.0	1.5	22.7	43.5	33.0
13		1.0	4.0	8.0	3.0		6.0	4.0	8.5	3.0	23.5	41.2	33.0
14		16.0	2.7	3.0	2.5		21.0	2.7	2.5	2.5	22.5	44.5	36.5
15		6.0	3.0	7.0	0.0		16.5	3.0	2.5	1.0	22.0	39.0	32.0
16		16.0	4.0	3.5	1.5	1.0	19.0	3.0	4.0	1.5	21.5	43.0	34.0
17		15.5	3.7	4.5	0.0		13.0	3.7	4.5	0.0	26.0	44.0	35.0
18		13.0	2.8	5.5	3.0		11.0	3.0	6.5	1.5	22.0	42.0	32.0
19	1.5	11.0	2.8	4.0	3.0		16.0	3.0	1.5	3.0	25.5	45.0	39.0
20		12.0	3.5	4.5	2.0		10.5	3.5	4.5	2.5	26.0	44.5	40.0
Mean		10.3	3.1	4.8	1.3	0.1	12.0	3.1	4.6	1.5	23.9	41.7	34.7

M-C: The distance, in millimeters, between M-M′ and C-C′, measured along the midline.

M Forward: The relative forward position, in millimeters, of the right or left upper first permanent molar to the other molar, measured parallel to the midline.

C Forward: The relative forward position, in millimeters, of the right or left canine to the other canine, measured parallel to the midline.

2. *Rotation of the Upper First Permanent Molar.*—

M and M′ Angles: The angles formed by the X and Y lines, respectively, with the midline.

X-C, Y-C′: The distance, in millimeters, from C to line X, and C′ to line Y along the line C-C′. This measurement is positive if X or Y intersects the extended line C-C′.

(*Note:* Because of the position of the canines in certain cases [Fig. 6], this measurement and others relating to the canines had to be omitted.)

M-A, M′-B: The perpendicular distance, in millimeters, of A and B from M-M′.

3. *Mesial Inclination of the Upper First Permanent Molar.*—

Canine: The distance of the incisal tip of the fully erupted canine (C and C′) relative to the X and Y lines in the vertical plane. The reading is positive above C or C′ and negative below.

RESULTS AND DISCUSSION

Class I extraction cases exhibited narrower arches (M-M′ and C-C′) than normal and yet a larger molar-to-canine distance. This is in keeping with two possible causes of this type of malocclusion: (1) large teeth and/or (2) deficient apical base. The right molar was more frequently forward and was, on an average, 0.7 mm. further forward than the left, but this is of little importance.

Class II, Division 1: The narrower palate, typical of this type of malocclusion, was noted and the increase in M-C measurement was obviously a result of anteriorly flared upper anterior teeth.

Class II, Division 1 subdivision: The subdivision was very similar to Class II, Division 1, varying only in the forward position of the molar on the Class II side in all but two cases. This would seem to indicate a definite forward movement of the buccal segment on the affected side.

Class II, Division 2 readings were very similar to normal, with the possibility of a slightly narrower arch.

Inclined plane relationship (molar position): The position of the mesiolingual cusp of the upper first permanent molar was studied in all cases of malocclusion. It was observed that there were three main positions which it may occupy in these types of malocclusion:

Position 1 (or normal): The mesiolingual cusp of the upper first permanent molar fitting into the central fossa of the lower first molar.

TABLE II. CLASS I EXTRACTION

	RIGHT						LEFT								
PATIENT	MOLAR POSITION	M FORWARD (MM.)	M ANGLE (DEGREES)	M-A (MM.)	X-C (MM.)	CANINE (MM.)	M′ POSITION	M′ FORWARD (MM.)	M′ ANGLE (DEGREES)	M′-B (MM.)	Y-C′ (MM.)	CANINE (MM.)	M-C (MM.)	M-M′ (MM.)	C-C′ (MM.)
1	1		21.0	5.0		−1.0‡	1		18.5	4.0		(2.0)‡		37.5	
2	1	4.6	26.3	4.0	0.5	(1.0)‡	1		10.5	3.5	3.5	(0.0)‡	26.5	45.0	37.5
3	1	4.0	23.3	4.0		(0.0)‡	1		18.7	4.0	1.0	−1.0		42.0	
4	1*		12.0	4.0	2.5	−1.0	1*		15.3	4.0	1.5	−3.0	26.0	40.0	34.0
5	1*	0.5	24.3	4.5	−1.0	−1.0	1		25.3	4.0	−3.0	−0.8	25.2	38.0	30.5
6	1	1.2	23.2	5.0	0.0	−1.6	1		20.0	3.5	0.0	1.8	25.0	43.0	35.0
7	1	0.0	9.8	3.5	3.0	1.0	1		19.5	4.0	−2.0	2.2	25.5	35.2	32.0
8	1	0.0	7.0	4.0	6.0	−1.5	1		7.5	4.0	4.0	1.0	25.2	37.0	32.5
9	1	1.0	22.4	4.5		(0.0)‡	1		26.4	5.0	−1.0	0.0		42.0	
10	1	1.5	10.4	3.5	3.0	−2.0	1		15.5	3.5	0.5	−2.0	24.8	38.0	35.0
11	2		22.5	4.0	−4.0	−1.5	1		1.0	3.5	7.0	(−1.0)‡	26.0	39.0	36.0
12	1	1.5	18.7	4.0	−1.0	(1.5)‡	1		11.0	3.0		(0.5)‡	24.8	43.5	38.5
13	1		26.8	4.0		(−2.5)‡	1	1.5	18.0	4.0	−3.0	(−2.0)‡	26.2	36.5	32.0
14	1		31.2	4.5	−2.0	−3.0	1	1.5	26.0	3.5	−0.5	−1.0	25.5	46.0	34.5
15	1	1.5	22.0	4.5	0.0	−1.0	1		21.5	4.5	2.0	−1.0	24.2	45.0	36.5
16	1		20.0	5.0	1.0	3.0	1	2.0	13.5	3.5	4.5	2.5	26.0	40.0	33.0
17	1		20.6	4.0	1.5	(0.5)‡	1		24.0	4.5	−1.0	−1.0	25.0	40.0	33.0
18	1	2.8	22.5	3.0	0.0	0.5	1		17.0	3.5	0.0	2.0	25.2	38.0	33.0
19	1†		22.3	4.0	2.0	−3.0	1†		11.0	4.0	1.0	−3.0	26.0	40.0	38.0
20	1*	2.0	10.0	4.0		(−1.5)‡	1*		1.0	4.0		(0.0)‡		40.0	
21	1	0.0	15.0	3.0	0.5	1.0	1		17.5	3.0	1.5	0.0	24.5	35.0	29.5
22	3	4.0	24.0	4.0		(1.0)‡	1		6.5	4.0		(1.0)‡		38.5	
23	3		17.5	4.0	−2.0	(−1.0)‡	1		12.6	4.0		(0.5)‡		41.0	
24	1		19.0	4.5	3.0	−1.0	1*		10.5	3.5	2.0	0.5	24.5	38.5	34.0
25	1		16.3	4.0	−3.0	1.8	1		8.0	2.5	5.0	−1.5	27.0	38.0	36.0
Mean		0.7	19.5	4.0	0.5	−0.6			15.1	3.8	1.0	−0.2	25.4	39.9	34.2

*Molar slightly mesial to Position 1.
†Molar slightly distal to Position 1.
‡Measurement on first premolar.

TABLE III. CLASS II, DIVISION 1

	RIGHT							LEFT									
PATIENT	MOLAR POSITION	M FORWARD (MM.)	M ANGLE (DEGREES)	M-A (MM.)	X-C (MM.)	C FORWARD (MM.)	CANINE (MM.)	M′ POSITION	M′ FORWARD (MM.)	M′ ANGLE (DEGREES)	M′-B (MM.)	Y-C′ (MM.)	C′ FORWARD (MM.)	CANINE (MM.)	M-C (MM.)	M-M′ (MM.)	C-C′ (MM.)
1	2	0.0	21.0	5.0	1.0	3.0	–1.0	3		16.0	4.0	3.0		3.0	23.2	39.0	31.0
2	3*	0.0	18.5	4.5	1.5	1.0	0.0	3		16.0	5.0	4.5		–1.0	25.0	39.5	31.0
3	3	0.0	25.0	5.0	0.0	0.0	–2.0	3		18.0	4.8	0.5		–1.0	27.8	44.5	35.5
4	3	0.0	17.0	3.5	4.0	2.0	2.0	3		17.5	3.0	1.5		1.5	23.0	38.5	31.0
5	3	0.0	21.5	4.0	0.0	0.0	2.0	3*		29.0	4.0	–2.0		2.0	24.0	42.5	35.0
6	3	0.0	22.5	4.3	0.0	0.0	–4.0	3		16.5	3.8	3.0	1.0	–4.0	25.0	38.0	31.5
7	2		13.5	3.0	2.5		3.0	3	1.0	9.5	3.0	8.0	0.0	2.0	24.8	44.0	35.0
7	2		30.0	5.0	–2.0		–2.0	3	1.0	23.0	4.3	–1.5		0.0	23.5	36.0	30.0
9	2	0.0	21.0	6.0	1.5	2.0	–1.0	3		16.3	3.0	1.8	1.5	–1.0	25.5	40.0	33.0
10	3		11.0	3.0	3.0		–3.0	3	1.5	13.5	3.0	3.0		–4.0	24.0	40.0	34.5
11	3	2.0	26.5	3.8	0.0	1.0	0.0	3		17.5	4.5	1.0		0.0	25.0	40.0	32.0
12	2	2.0	21.0	4.0	1.0	0.0	1.0	2		23.3	4.0	0.0	2.5	0.5	23.5	38.5	31.0
13	3		15.5	3.0	0.0		2.0	3	2.0	14.0	3.5	2.5		2.0	24.0	38.0	35.0
14	2	1.5	9.5	4.0	5.0	0.5	1.0	2		18.5	4.0	2.5		1.5	25.0	39.0	32.0
15	3		17.0	4.0	1.5	2.0	–2.0	3		21.0	3.5	0.0	0.0	0.0	23.5	40.0	34.5
16	2		25.0	5.0	–3.0		–1.0	3	2.0	20.0	4.5	–1.0	1.0	–1.0	25.0	39.0	34.0
17	3		16.8	3.0	1.5		0.0	3	1.5	24.0	3.5	0.0		0.0	23.8	38.0	30.0
18	3	0.0	21.0	4.0	0.0	0.0	–2.0	3		7.0	3.5	5.0	2.0	2.0	26.3	41.0	35.0
19	3		16.0	4.0	3.5		1.0	3	2.0	18.0	3.0	2.5		0.0	26.3	45.0	35.0
20	3	1.5	20.5	4.0	1.5	1.5	–3.0	3		18.0	3.5	0.5	1.0	–1.0	26.0	40.5	35.0
21	2		17.5	3.0	3.5		0.5	3	0.0	15.8	3.0	2.0		–0.5	23.2	37.5	29.5
22	2	1.0	25.0	3.8	–0.5	1.0	2.0	2		19.0	3.5	0.0	1.0	2.0	25.5	40.0	34.0
23	2		12.0	4.5	3.0		0.0	2	1.0	15.5	4.0	2.0	1.0	–1.0	26.0	44.0	37.0
24	3		15.5	3.5	3.5		0.5	3		20.5	3.0	0.5		0.0	24.5	44.0	34.5
25	2	2.5	17.0	3.8	4.0	2.5	–2.5	3		8.0	4.0	3.5	1.5	–2.0	24.5	41.0	33.0
26	3		21.0	4.0	0.5		–2.0	3	1.5	16.5	3.7	1.0	1.5	1.0	24.5	35.5	31.0
27	2		23.5	4.7	–1.0		–2.0	3*	1.5	14.0	3.7	3.0	2.0	–1.0	22.5	38.5	31.0
28	2		36.0	4.5	–8.0		–2.0	1	0.5	18.5	4.0	0.0	2.5	–7.0	26.0	42.0	36.0
29	3		21.0	3.0	–1.0		0.0	3	2.5	30.0	3.0	–3.0		–3.0	24.0	38.0	33.0
30	3	0.0	22.0	5.0	0.0	0.0	–3.0	3		13.0	3.5	4.0		–3.0	27.0	41.0	33.5
Mean			20.0	4.1	0.9		–0.6		0.3	17.6	3.7	1.6	0.1	–0.4	24.7	40.1	33.1

*Inlocked lower premolars.

TABLE IV. CLASS II, DIVISION 1 SUBDIVISION

	CLASS II SIDE						CLASS I SIDE						
PATIENT	MOLAR POSITION	M FORWARD (MM.)	M ANGLE (DEGREES)	X-C (MM.)	C FORWARD (MM.)	CANINE (MM.)	M′ POSITION	M′ ANGLE (DEGREES)	Y-C′ (MM.)	CANINE (MM.)	M-C (MM.)	M-M′ (MM.)	C-C′ (MM.)
1	3*	5	23.8	0	1	−2.3	1*	31	−4	−3	25.3	37	30
2	2	1	21.2	0.5	1.3	1.5	1	24.3	−1	−1.5	25	40	33.5
3	2	0	27	−3	0	−3	1	20.5	−0.5	−2.5	25.5	38	31.5
4	3	0	26	−3	1.5	0.5	1	22.8	−0.5	−0.5	24.2	39.5	32.5
5	2	2.5	11	5	2.8	−2.3	1	2	5	−1	25.2	41	36.5
6	3	2.2	15.3	4	1.8	0	1	11	3	−2	23	40	33.8
7	2	4	25	−1	4	0	1*	8.7	1	0	24.8	35.5	31.5
8	3	2	12.5	3.5	1.5	2.3	1	8	6.5	−1.5	22.8	38.5	28.5
9	2	1	21.7	1	1.6	2	1	23.8	1.6	2	27	38.2	29
10	3	2	30	−3	4	1	1	22.6	−1	2	24.2	37	31.8
11	2	1	22		0	(0)†	1	21		(−1)†		41	
12	3	1.8	9.5	5	1.8	−1.5	2	15	2	−1.5	26	38.5	32.5
13	3	2.5	6	4	4	1	1	20	0.5	1	27	40	35
14	3	3.2	11.5	4.7	1.7	−2	1	8.1	6.1	−2	27.8	45	35.2
15	2	2	28	−3.5	2	−0.5	1	28	−2	2	25.8	42.5	35
16	2	1	24.2	0	1.5	−1.5	1	12	2.2	−1.5	23	37.3	31
17	3	1	7	4	1	3	2	12.3	4.7	3	25.5	39.6	33.5
18	2	2	20.1			(−1)†	1	14.5		−1.5		38	
19	3	1	11	4	0	−1.5	1	4	6	−1	24	41	36
20	3	0.5	23.3	0	1.5	1	1	14.3	4.5	1.5	23.5	41	32.5
Mean		1.8	18.8	1.1	1.7	−0.1		16	1.7	−0.5	25	39.9	32.7

*Molar slightly mesial.
†Measurement on first premolar.

TABLE V. CLASS II, DIVISION 2

	RIGHT						LEFT								
PATIENT	MOLAR POSITION	M FORWARD (MM.)	M ANGLE (DEGREES)	X-C (MM.)	C FORWARD (MM.)	CANINE (MM.)	M′ POSITION	M′ FORWARD	M′ ANGLE (DEGREES)	Y-C′ (MM.)	C′ FORWARD (MM.)	CANINE (MM.)	M-C (MM.)	M-M′ (MM.)	C-C′ (MM.)
1	3	1	14.5	3.5	2	−1.2	3		14.5	4		0	24	42	33
2	2	0	21	1	0	−2.2	3		16.5	2		−1.2	25.5	40.5	33
3	3	2.5	21	−1	2.5	−2	1		20.5	−1.5		−1.5	23.5	37.5	34.5
4	3	1	18.5	4	0.5	2	2		14.5	3.5		1	22	43	32.5
5	3		18	−1		−1	3	1.5	7	4	0	0	24	38.5	35
6	2	2	18.5	3	1.5	2	3		23	1		6	23	40	31.5
7	2		18	0		−1	2	1	14.5	3	1	1	25	40	33.5
8	2		19.5	−1		0	2	1.5	21.5	−2	1.5	−1	25.5	42	38
9	3	1	17.5	2	1	0	1*		15.5	2		0	23	38.5	32
10	2	1	28.5	−2	2	−1.8	2		22.5	0		0	25	41	31.5
11	3	2	15.5	5.5	2	0	3		17	6		−1	22	44	31
12	3	0.5	23.3	0	1.5	1	2		14.3	4.5		1.5	23.5	41	32.5
13	2		16	2		−1	2	3	22.5	−0.5	3	−1	22.5	39	33
14	3		13.8	6		3	3	1.5	8.5	7	1	2	23	41	31
15	3	1.5	23			−1	2		20			0		38	
16	3		13.5	4		2.5	3	2	11	4	2	1	21.5	40	34
17	1*		16	1		−1	1*	1	16.5	2.5	1	−0.5	24	41	34
18	3	0	23.5	1	0	0	3		10	4.5		2	19.5	36	29
19	2	1	22.5	1	1	−2	2		19	2.5		2	22	39.5	30
20	2	1	27	−1.5	0	−2	2		24	−1.5		−2	23	40	35
Mean		0.1	19.5	1.3	0.2	−0.3			16.9	2.2		0.4	24.3	40.1	32.9

*Molar mesial to Position 1.

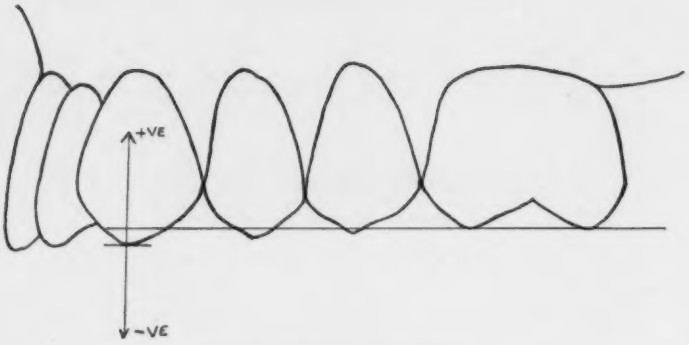


Fig. 7.—Canine measurement.

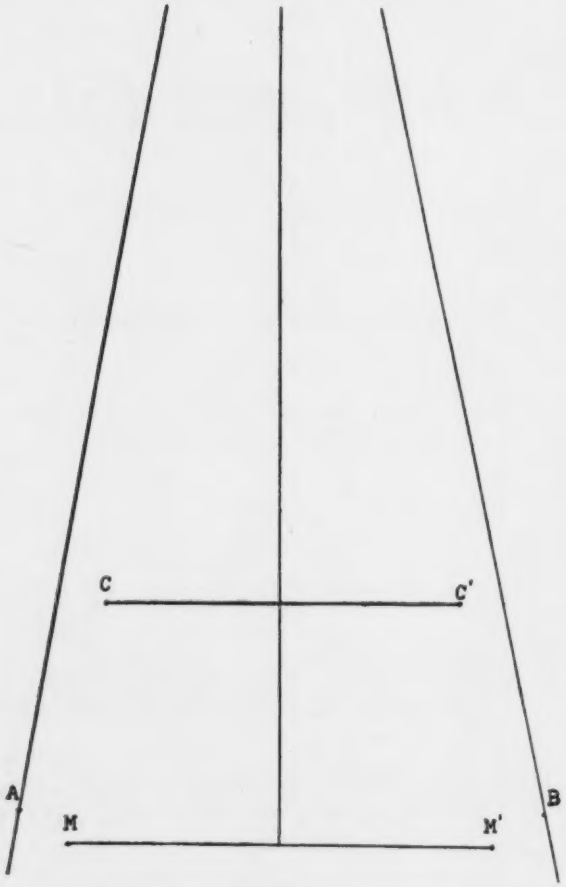


Fig. 8.—Graph of the mean normal.

Position 2: As the upper molar moves forward, the mesiolingual cusp fits into the depression surrounded by the marginal ridge and the mesial slope of the buccal and lingual mesial cusps of the lower first permanent molar.

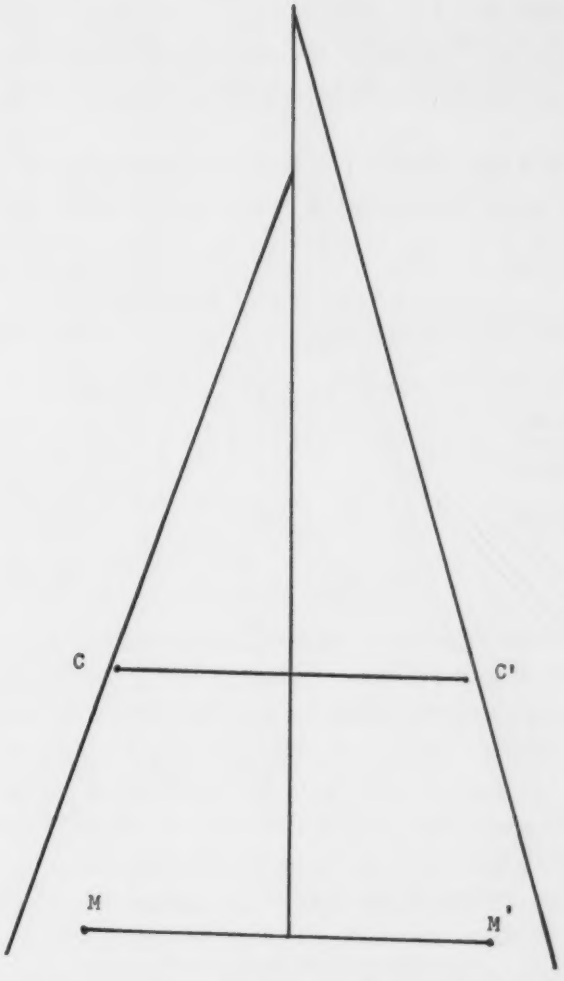


Fig. 9.—Graph of the mean Class I extraction.

Position 3: In most Class II, Division 1 malocclusions the molars were found to be in Position 3, that is, the mesiolingual cusp occluding in the embrasure between the lower second premolar and the lower first molar. There was a greater rotation of the molar associated with Position 2 than with Position 3, the mean M angle for Position 2 being 21.3 and, for Position 3, 17.4 degrees.

Study of the lingual aspect of the models was necessary to determine the position of the lingual cusp, the buccal aspect being very similar for both

TABLE VI. DENTURE PATTERN

TYPE OF OCCLUSION	M-C (MM.)	M-M′ (MM.)	C-C′ (MM.)	RIGHT		LEFT	
				M FORWARD (MM.)	C FORWARD (MM.)	M′ FORWARD (MM.)	C′ FORWARD (MM.)
Normal	23.9	41.7	34.7			0.1	
Class I Extraction	25.4	39.9	34.2	0.7	0.5		
Class II, Division 1	24.7	40.1	33.1			0.3	0.1
Class II, Division 1 Subdivision	25	39.9	32.7	1.8	1.7		
Class II, Division 2	24.3	40.1	32.9	0.1	0.2		

Positions 2 and 3 of the molar. The distal movement of the upper first permanent molar is obviously accomplished much more readily from Position 2 than from Position 3.

TABLE VII. MESIAL INCLINATION

TYPE OF OCCLUSION	RIGHT CANINE (MM.)	LEFT CANINE (MM.)
Normal	1.3	1.5
Class I Extraction	–0.6	–0.2
Class II, Division 1	–0.6	–0.4
Class II, Division 1 Subdivision	–0.1	–0.5
Class II, Division 2	–0.3	0.4

AXIAL RELATION

1. *Sagittal Plane (Canine).*—Normal cases showed a mesial axial inclination of the upper first permanent molar as measured by the X and Y lines. These passed through the upper canine 1.3 mm. on the right and 1.5 mm. on the left from the tip of the canine. The mean reading for each of the malocclusions studied (except for the left side in Class II, Division 2) was negative. This indicates a distal axial inclination and it must be concluded that *mesial tipping of the upper first molars in these types of malocclusion is not the general rule.* This, as Strang[17] suggests, is because of the mesial tilt of the lower molars, a usual occurrence in deep-bite cases. The upper molars tend to align their axial positions to conform with the lower molars. Correct treatment procedure in Class II cases must aim at eventual bodily distal movement of the upper first permanent molar rather than a distal tipping.

TABLE VIII. ROTATION

TYPE OF OCCLUSION	RIGHT			LEFT		
	M ANGLE	M-A (MM.)	X-C (MM.)	M′ ANGLE	M′-B (MM.)	Y-C′ (MM.)
Normal	10.3	3.1	4.8	12	3.1	4.6
Class I Extraction	19.5	4.0	0.5	15.1	3.8	1.0
Class II, Division 1	20.0	4.1	0.9	17.6	3.7	1.6
Class II, Division 1 subdivision	18.8		1.1	16		1.7
Class II, Division 2	19.5		1.3	16.9		2.2

2. *Occlusal Plane—Rotation (M and M′ Angle, X-C, Y-C′, and M-A, M′-B).—*

Normal: The line passing through the buccal cusps of the upper first permanent molar in the horizontal plane meets the midline at a mean angle of 11.1 degrees and passes 4.7 mm. to the buccal of the canine. It is this low M angle reading that gives the upper dental arch the offset buccally as it passes from the second premolar to the first molar area.

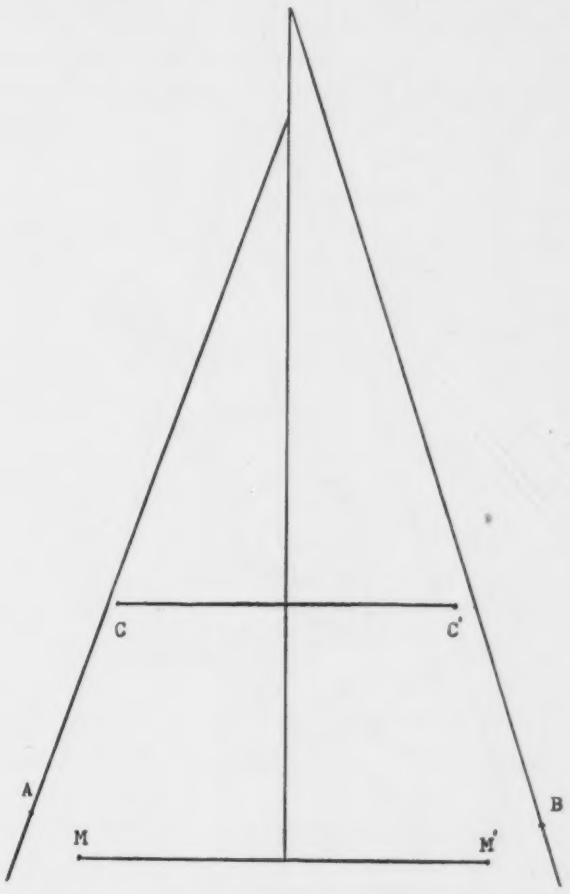


Fig. 10.—Graph of the mean Class II, Division 1.

Malocclusion: All types of malocclusion studied exhibited rotation of the molar as a general rule. Hellman[18] observed the same fact. He reported: "In 800 cases of malocclusion studied there was a high percentage of rotation. This rotation seems to occur in such a manner as to bring the buccal cusps into an even buccal plane with the rest of the teeth." The low readings of X-C and Y-C′ verify this statement. M-A and M′-B readings reveal that an average of approximately 1 mm. of space mesial to the molar may be gained if these molar rotations are corrected during orthodontic treatment.

The size and position of the palatal root of the tooth play an important part in the rotation of the upper first molar. Atkinson[19] drew attention to the inward growth of the hard cortical bone of the alveolus anterior to the palatal root (Fig. 12). There is, therefore, a pivotal axis passing through the mesiolingual cusp and the palatal root of the tooth around which the molar tends to rotate. The very shape of the alveolar process favors this rotation of the tooth within the bone (Fig. 12).

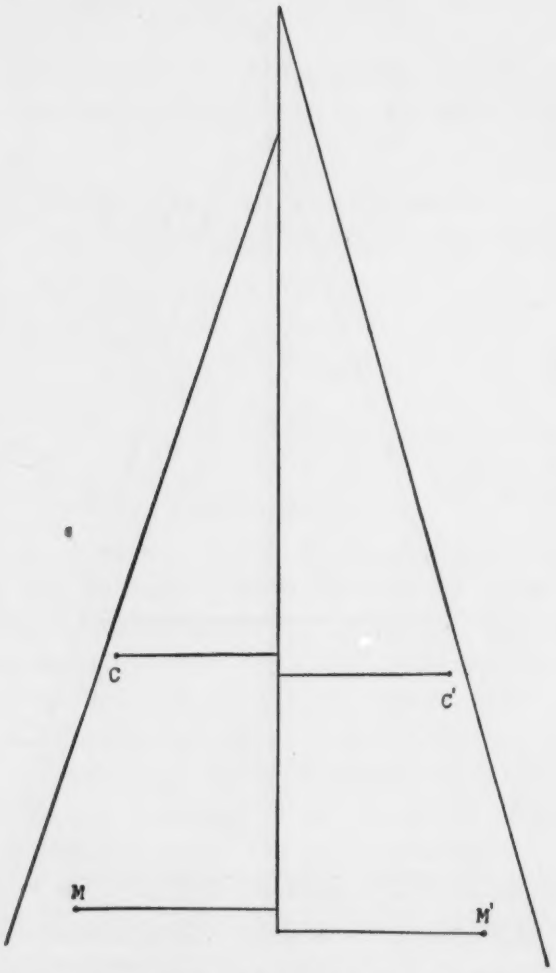


Fig. 11.—Graph of the mean Class II, Division 1 subdivision.

This rotation is always a result of an anterior force component in excess of normal or the lack of anterior resistance because of a break in the arch or forward movement of the teeth anterior to the molar from muscle dysfunction.

MESIAL DRIFT

The regular mesial position of the buccal segment on the Class II side of Class II, Division 1 subdivision cases is indicated by the forward position of

the molar and canine, mean figures being 1.8 mm. and 1.7 mm., respectively. It is also accompanied by a more severe rotation of the molar, a mean of 2.8 mm. on the affected side. The canine reading of –0.1 mm., however, rules out any possibility of a general tipping of the molar but, rather, points to a bodily forward position of the upper first molar.

CONCLUSIONS

1. There is a tendency to mesial movement of the upper first permanent molar in Class I and Class II malocclusions.

2. This tendency is definitely increased by abnormal muscle pressures, such as thumb-sucking and incorrect swallowing.

3. If the upper first molars are forward they are, as a general rule, bodily forward and not tipped.

Fig. 12.—Transverse section of the roots of the upper first permanent molar.

4. The upper first permanent molars in the malocclusions studied are rotated in approximately 83 per cent of the cases, and the axis of rotation passes through the palatal root and mesiolingual cusp.

5. The space obtainable mesial to the upper first permanent molar by correcting the rotation is approximately 1 mm.

6. There are three main positions that the mesiolingual cusp of the upper first permanent molar occupies in the malocclusions studied.

7. A careful survey of each case of malocclusion is necessary to determine treatment objectives.

REFERENCES

1. Angle, E. H.: Malocclusion of the Teeth, ed. 7, Philadelphia, 1907, S. S. White Dental Mfg. Co., chap. I, p. 10.
2. Stoller, Arnold E.: The Normal Position of the Maxillary First Permanent Molar, Am. J. Orthodontics **40**: 259-271, 1954.
3. Hellman, Milo: An Interpretation of Angle's Classification of Malocclusion of the Teeth Supported by Evidence From Comparative Anatomy and Evolution, Dental Cosmos **62**: 495, 1920.
4. Strang, R. H. W.: Discussion of Milo Hellman's Paper, Dental Cosmos **62**: 541, 1920.
5. Hemley, S.: Fundamentals of Occlusion, Philadelphia, 1944, W. B. Saunders Company, chap. VI, p. 147.
6. Stoller, Arnold: The Normal Position of the Maxillary First Permanent Molar, Am. J. Orthodontics **40**: 259-271, 1954.
7. Hellman, Milo: The Relationship of Form to Position in Teeth and Its Bearing on Occlusion, Dental Items Interest **42**: 250, 1920.
8. Strang, R. H. W.: Textbook of Orthodontia, London, 1950, Henry Kimpton, chap. II, p. 43.
9. Angle, E. H.: Malocclusion of the Teeth, ed. 7, Philadelphia, 1907, S. S. White Mfg. Co., chap. I, pp. 17-21.
10. Stallard, H.: The Anterior Component of the Force of Mastication and Its Significance to the Dental Apparatus, Dental Cosmos **65**: 457-474, 1923.
11. Hemley, S.: Fundamentals of Occlusion, Philadelphia, 1944, W. B. Saunders Company, chap. 9, p. 258.
12. Dewel, B. F.: Clinical Observations on the Axial Inclination of Teeth, Am. J. Orthodontics **35**: 98-115, 1949.
13. Swinehart, E. W.: Relation of Thumb Sucking to Malocclusion, Am. J. Orthodontics and Oral Surg. **24**: 509, 1938.
14. Strang, R. H. W.: Textbook of Orthodontia, Henry Kimpton, chap. IX, p. 146.
15. Fischer, Bercu: Orthodontics, Philadelphia, 1952, W. B. Saunders Company, chap. II, p. 18.
16. Johnson, E., Young, M., Smyth, C., and Still, M.: Investigations Into the Nature and Characteristic Features of Post-Normal Occlusion, Medical Research Council, Special Report Series No. 225, London, 1937, His Majesty's Stationery Office.
17. Strang, R. H. W.: Textbook of Orthodontia, London, 1950, Henry Kimpton, chap. IX, p. 144.
18. Hellman, Milo: An Interpretation of Angle's Classification of Malocclusion of the Teeth Supported by Evidence From Comparative Anatomy and Evolution, Dental Cosmos **62**: 494, 1920.
19. Atkinson, S. R.: The Mesiobuccal Root of the Maxillary First Molar, J. South. California D. A. **19**: 17-27, 1951.

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THE EXTRACTION INDEX

A Proposal

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THERE is no doubt that extraction in orthodontics has come to stay. It is unfortunate that the prolonged discussion of the basic question as to whether extractions were justified at all has postponed investigations into the matter of when, where, and how much to extract. To answer the first question ("When to extract?") would be the task of a differential diagnosis. "Where to extract?" would have to be answered when treatment is planned, and with this answer would be automatically connected the reply as to how much to extract.

It seems, judging from publications, that there is at present a tendency to extract four teeth as a matter of routine. Under these circumstances, of course, it is satisfactory to state that extractions are made in 50, 60, or 70 per cent of the cases. There are certain anomalies, however, where the routine extraction of four teeth is neither necessary nor advisable. There is, for instance, the occurrence of asymmetries, such as a forward translation of the lateral teeth on one side with an ectopic cuspid. If such a condition has been brought about by premature extraction of a deciduous tooth and the relationship between the size of the teeth and that of the jaws is normal, we will, of course, rebuild the arch along conservative lines, that is, without extraction. If, however, there exists a disrelation between the sizes of the teeth and jaws, respectively, and this disrelation is of a moderate degree so as not to warrant the reduction by two units, then we will gladly resort to unilateral extraction.

Routine extraction of four teeth is also contraindicated in cases where there exist disrelations, rare though they are, between the sizes of the teeth in the upper and lower jaws. Extractions in one jaw only are imperative here.

A chapter for itself is the problem of the lower incisors, but the time has not yet come to write this chapter. Suffice it to say that in certain cases the extraction of one incisor, generally a lateral one, seems to be the obvious solution.

Time and experience will be necessary to elucidate these and other problems which were only sketched here in the barest outline. It was done to show that, if the routine extraction of four teeth is not always indicated now and will probably become more restricted in the future, then general statements like "extractions in such and such a percentage of cases" are insufficient and

may even be misleading. If author X speaks of extractions in 60 per cent of his cases, but the number of his extractions varies from one to four according to the individual case, he may extract less teeth than author Y, who extracts in 50 per cent only but always extracts four teeth.

Table I shows that Y, though extracting in only 50 per cent of his cases, actually extracts about 50 per cent more teeth than X, who extracts in 60 per cent of his cases.

TABLE I

NUMBER OF EXTRACTIONS	X		Y	
	NUMBER OF CASES	TEETH EXTRACTED	NUMBER OF CASES	TEETH EXTRACTED
0	40	0	50	0
1	20	20		
2	15	30		
3	15	45		
4	10	40	50	200
	100	135	100	200

These are constructed examples, of course, but they serve to demonstrate that sources of error exist if one reports the percentage of extraction cases only and does not give a more specific statement. Although specifications like those given in Table I would be advisable in certain investigations, their general application would be too cumbersome.

Another solution would be to supplement the percentage of extraction cases with a statement about the average number of extractions per case, but such a procedure would still necessitate the use and calculation of two numbers. It would be preferable to give the necessary information by one number only, and it is for this purpose that an "extraction index" is proposed. The formula is as follows:

$$\text{Extraction index} = \frac{\text{Number of extracted teeth} \times 100}{\text{Number of cases.}}$$

It might be stated expressly that "number of cases" in the denominator should represent the number of *all* cases of a given sample, that is, extraction and nonextraction cases together. In the two examples of Table I, the extraction indices would be 135 and 200, respectively, since the number of cases was 100 in each sample. It would be fallacious, of course, to compute indices of too small samples. A minimum would be about 50 cases, but samples of 100 cases or over would, of course, be preferable.

There remain to be explained the uses to which such an index might be put. If one regards extractions as a kind of necessary evil, then, everything else being equal, a method which yields good results with a low extraction index would have preference over a method with a higher one. Furthermore, it might be possible to find a relationship between the number and/or degree of relapses and the extraction index. Or, again, one could compare the duration of treatment in samples with different extraction indices.

Although generally such investigations would be made with regard to different schools of thought or systems of appliance, it could also be interesting for an orthodontist to compare the number of extractions at different periods. It might become clear from such an investigation that, while the percentage of extraction cases remained the same, the number of extractions altered appreciably as a result of a change in approach or method. Such a change might have come about in so gradual and nearly subconscious a way that, without the sensitiveness of the extraction index, it would never have come to light.

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Abstracts Presented Before the Research Section of the American Association of Orthodontists, San Francisco, May 11, 1955

A Systematic Analysis and Classification of the Dentofacial Abnormalities Shown in Cerebral Palsy (Read by Title): By Glenn E. Jackson, B.A., D.D.S., Northwestern University Dental School, Chicago, Ill.

The dental problem of cerebral palsy children is considered to be of two spheres: (1) dental diseases and deformities and (2) dental treatment. Prominent in the category of dental diseases and deformities is, of course, the striking need for some type of orthodontic treatment. Deformities of the dental arches and malocclusions appear in many cases as the result of the abnormal muscular forces that influence the development of the oral mechanism. This investigation was undertaken to determine the incidence of dentofacial abnormalities and dental arch deformities occurring in cerebral palsy children.

The study is based on a clinical examination of eighty-four cerebral palsy children of the white race. The group was composed of forty-five boys and thirty-nine girls, representing the spastic, athetoid, ataxic, and rigidity types of cerebral palsy. The method of collection of data utilized was clinical, that is, direct subject observation, with additional records, plaster models, and cephalometric radiographs of selected subjects. Angle's classification of malocclusion was used. To evaluate properly the incidence of malocclusion and dental arch deformities in the cerebral palsied, it was necessary that the results of the clinical survey be evaluated in comparison with those gained from a study of the distribution of occlusions in a group of normal children. For this purpose, the results of a study of 380 children were utilized.

The investigation gave evidence that cerebral palsy children with deciduous dentitions presented a greater number of normal occlusions or malocclusions of a less severe nature than those older children with mixed deciduous-permanent dentition or complete permanent dentition. The influence of the deranged neuromuscular complex upon the dentoalveolar structures, continuing over a period of time, brings about a maldevelopment by causing a loss of equilibrium in the functional unit formed by the skeletal framework of the maxilla and mandible and their muscular attachments. The variation in the normal tonus of the muscles of the face, most often hypertonicity, as is often present in cerebral palsy, and perversion of the muscular actions associated with the acts of swallowing and speech, characteristic clinical features of cerebral palsy, are important from an etiological standpoint as causes of the malocclusions and arch deformities. Intrinsic factors favorable to the pro-

duction of a malocclusion, such as premature loss of deciduous teeth and loss of permanent teeth, play an even greater role in the cerebral palsy child, due to the problem of hygiene and proper dental treatment.

The distribution of occlusions within each of the medical classifications of cerebral palsy was included in the research.

A further study was made of functional disturbances of the oral mechanism associated with cerebral palsy. This showed 36 per cent of the subjects exhibiting abnormal temporomandibular joint function, caused, in all probability, by the unbalance prevailing in the neuromuscular mechanism or the malocclusion of the teeth. Abnormal patterns of abrasion, ranging from moderate to severe, appeared in 43 per cent of the cases.

The Correlation of the Inclined Planes of the Articular Surfaces of the Glenoid Fossa With the Cuspal and Palatal Slopes of the Teeth (Read by Title): By Dr. Edith Koyoumdjisky, Columbia University, School of Dental and Oral Surgery of the Faculty of Medicine, New York, N. Y.

An open craniophore and plane recorder were constructed to determine whether a correlation between the inclined planes of the articular surface of the glenoid fossa and the cuspal and palatal inclined planes of the teeth exists. Human skulls with normal occlusion and nonabraded teeth, ranging in age from approximately 35 years to about 7 years, were used. Measurements were limited to the glenoid fossa and the maxillary teeth. The plane recorder was constructed in such a way that movements in three dimensions could be recorded. Readings were taken at 1 mm. intervals and recorded on millimeter graph paper. Tangents were drawn to the cross-sectional images of the measured units and thus the angulation of the inclined planes was established in units of degrees.

The collected data were analyzed statistically. (1) The anterior slope of the glenoid fossa shows great individual variation. (2) The teeth exhibit a greater constancy in their inclined planes and show less variation between the two sides of the same skull, although the palatal slopes of the upper anterior teeth show greater individual variation than the cuspal slopes of the posterior teeth. (3) No significant difference was found between the mean slope of the articular surface of the glenoid fossa and that of the palatal slope of the upper anterior teeth, although the mean cuspal slope was found to be significantly different. (4) The correlation found between the articular slopes of the fossa and the dental slopes appear significantly different from zero at the 0.05 level. (5) All the statistical methods seem to indicate a closer relationship between the articular slope of the fossa and the palatal slope of the upper anterior teeth than between the fossa and the cuspal incline of the posterior teeth.

The Permanent Mandibular First Molar: Its Calcification, Eruption and Decay. By Izaac Gleiser and Edward E. Hunt, Jr., *Am. J. Phys. Anthropol.* **13**: 253-283, June, 1955 (a digest).

A group of twenty-five boys and twenty-five girls were selected at random. In most cases, lateral jaw radiographs of the right side of the face were taken at intervals of three months from birth to 18 months, and at intervals of six months from 18 months to 10 years of age. At the same time, clinical dental examinations were carried out and radiographs of the hand were taken. Calcification of the permanent first molar is entirely postnatal in most individuals, and its most active development extends over the first nine years of postnatal life.

A row of outline sketches was made of all the radiographic images of the permanent mandibular first molar for each child. From these sketches, fifteen stages of calcification were arbitrarily chosen. The stages of completion of the crown are evaluated primarily with reference to its mesiodistal breadth, and those of the roots with reference to the occlusal-apical height of the crown.

Histologic and radiographic studies indicate that the exact time of onset of cusp calcification is not determinable from a radiograph, since the center is microscopic in size. By the time a grossly visible mass of cusp tissue has calcified, however, this minute center can be seen radiographically as an inverted cone.

The sequence of appearance of centers of ossification in man generally follows a descending order of size. Centers with a large growth potential appear earlier than those whose volumetric contributions to the mature skeleton are smaller.

Variations in the sequence of calcification may chiefly affect the appearance of the distobuccal cusp. This center seems to have the same instability of first appearance as it has in its final size. The large mesiobuccal cusp appears early, as might be expected from its size, but the rest of the sequence does not exactly follow a descending order of size.

With the continued growth of the cusps, coalescence occurs, but variations in the angulation of the tooth relative to the film and the tube may mislead the observer who attempts to evaluate this process. The peripheries of the cusps fuse earlier than does the central portion of the occlusal surface.

At the 9-month level, only one boy of the eighteen showed a fusion of all centers; while five out of nineteen girls showed this degree of maturation. Even at 12 months six out of twenty-three boys had not attained a complete fusion of cusps, but all twenty girls had arrived at this stage.

In measuring the rates of dental and osseous calcification, an important consideration is their relationships to chronologic age.

Table 4 presents the basic findings in this study. For each stage, the standard deviation of chronologic age in months was calculated by the small sample formula.

TABLE 4

Chronology of calcification of the permanent mandibular first molar

STAGE OF CALCIFICATION	BOYS			GIRLS		
	N	Mean age	S.D.	N	Mean age	S.D.
		months			*months*	
Coalescence of at least 2 centers	22	7.0	1.4	22	7.0	1.4
Outline of cusps completed	20	20.7	3.0	18	19.5	2.6
Half of crown completed	17	28.4	4.5	20	25.9	2.8
2/3 of crown completed	14	35.1	4.0	18	32.3	3.0
Crown completed	17	41.5	5.6	21	39.3	4.2
Minimal root formation	16	45.0	4.9	19	42.3	3.7
1/4 of root completed	23	69.1	8.1	24	64.4	4.5
1/3 of root completed	17	74.1	9.2	20	69.0	5.3
1/2 of root completed	21	76.8	8.8	22	74.2	5.4
2/3 of root completed	22	84.3	8.4	18	80.7	5.9
3/4 of root completed	20	90.0	8.1	17	84.7	5.9
Root canal terminally divergent	22	100.4	7.7	16	94.1	8.1
Root canal terminally convergent	13	106.6	7.4	12	102.5	6.0

(From original of table 4, Gleiser and Hunt: *Am. J. Phys. Anthrop.*, N.S. 13: 261, 1955.)

The calcification of a tooth does not occur in isolation, but is intimately related to its eruption and to the growth of its surrounding tissues. The

chronology presented in Table 4 makes it possible to calculate a few approximate growth rates of the permanent mandibular first molar, and to relate these rates in turn to the growth of some of the adjacent tissues.

An important difference between the sexes occurs in the occlusal-apical elongation of the tooth, and also in its mature dimensions. Measurements from casts of a group of American children, compiled by Dr. C. F. A. Moorrees, revealed a mean mesiodistal diameter of the crown in males of 11.18 mm., while in females it was 10.74 mm. The female mean is 96 per cent of the male measurement.

Fig. 1.—Stage of calcification of the permanent mandibular first molar. (From original of Fig. 1, Gleiser and Hunt: *Am. J. Phys. Anthrop.*, N.S. 13: 282, 1955.)

A reasonable estimate of the duration of rapid growth of the tooth can be based on the assumption that calcification begins at 1 month of age and ends when the walls of the root canals become terminally convergent. This interval in boys, on the average, is therefore 105.6 months and, in girls, 101.5 months. The girls' interval is 96 per cent of that found in boys.

These findings indicate that the absolute incremental velocities of calcification in the two sexes are alike, and that the shorter span of rapid dental growth in the female is a simple function of the smaller ultimate size of her tooth.

The velocity of occlusal-apical growth is not constant throughout this span of time. In order to calculate its variations, average occlusal-apical

measurements of the tooth were related to average intervals of time between some stages of calcification. These findings suggest that much of the acceleration in the terminal growth of the crown occurs in the dentine.

At the end of this phase of rapid growth of the crown, its outline is completed. Then a period of slower calcification occurs while the roots are beginning to develop, and the only rapid calcification visible at this stage is the apical expansion of the cleft between the roots.

Once the roots have attained about one-third of their "completed" elongation, they enter a growth spurt which accounts for a considerable proportion of their total increase in length. Finally, the roots grow more and more slowly for an unknown span of years.

These data on clinical emergence, together with the calculations, show that the tooth elongates slowly when it has not yet emerged from the alveolus. Immediately prior to alveolar emergence, the only rapid calcification occurs at the cleft between the roots. This growth at the cleft coincides with two additional events in the pattern of eruption. One is the rapid resorption of bone surrounding the crown. The other event is apparently the change in the tilting of the tooth. Initially, the occlusal plane slopes downward mesially and lingually. With eruption, it becomes more nearly horizontal.

In the interval from alveolar to clinical emergence, the elongation of the tooth is still only moderately rapid. This finding contradicts the opinion of Schour that the speed of dental development is "most active and intense before eruption." This evidence indicates, on the contrary, that calcification is most rapid soon after clinical emergence, rather than just prior to it. After occlusion is attained, the roots elongate at a much slower rate, and continue to grow very slowly for years afterward (Table 6).

TABLE 6

Relationships of calcification, eruption and emergence

STAGE	BOYS		GIRLS	
	Mean age	S.D.	Mean age	S.D.
	months		*months*	
Crown completed	41.5	5.6	39.3	4.2
Minimal root formation	45.0	4.9	42.3	3.7
Alveolar emergence	64.6	8.0	61.2	7.7
1/4 of root completed	69.1	8.1	64.4	4.5
1/3 of root completed	74.1	9.2	69.0	5.3
Clinical emergence (Hurme, '48)	74.5	9.6	71.3	9.6
1/2 of root completed	76.8	8.8	74.2	5.4

(From original of table 6, Gleiser and Hunt: *Am. J. Phys. Anthrop.*, N.S. 13: 266, 1955.)

From serial dental casts, Dr. See Siong Tan and Mrs. Vilma R. Hunt have measured the eruption of some of the permanent teeth in a large group of children. These measurements of the right permanent mandibular first molar were available for three members of the present sample, and were therefore analyzed to ascertain the relationships between the occlusal-apical elongation of the entire tooth and the amount of occlusal-gingival eruption. This analysis provided information concerning the eruption of the tooth as it relates to the accompanying growth of the periodontal tissues. The findings in these cases are presented in Table 7.

In the interval from about "3/4 of the root completed" to the termination of its rapid growth, the root elongates considerably more than the increase in the occlusal-gingival height of the crown, as shown in Table 7.

TABLE 7

Increments of calcification and eruption of the permanent mandibular first molar

STAGE	AGE INTERVAL	ESTIMATED AMOUNT OF ROOT ELONGATION	AMOUNT OF OCCLUSAL-GINGIVAL INCREASE
	years	*mm*	*mm*
Case 74 (female)			
1/2 root to 3/4 root	7–8	3.3	1.4
3/4 root to "completion"	8–9½	3.3	0.2
Case 149 (female)			
3/4 root to "completion"	6½–8	3.3	0.9
Subsequent growth	8–16½	?	2.1
Case 65 (male)			
1/2 root to 3/4 root	7½–9	3.3	0.9
Subsequent growth	9–13	3.3	0.8

(From original of table 7, Gleiser and Hunt: *Am. J. Phys. Anthrop.*, N.S. 13: 267, 1955.)

Once the root canals become fully convergent toward their apices, the subsequent elongation of the roots is protracted but slight. Along with this slight growth of the roots, the gingival-occlusal height may also increase slightly in some individuals, but whether this later increase equals the amount of terminal growth of the roots is unknown.

Although the relationships between calcification and eruption appear reasonable in terms of averages, individual variations in these events are equally important.

The interval of six months between radiographs and clinical examinations of the oral cavity does not permit a precise determination of the time of clinical emergence. Since the same interval applies to alveolar emergence, the comparisons in this table are actually quite meaningful. It is evident that the variability in root development is moderate at the time of alveolar emergence, but far greater at the time when the tooth was first seen in the oral cavity. As shown previously, since the elongation of the root in the occlusal-apical direction is much less rapid at alveolar emergence than it is at or soon after clinical emergence, this finding is entirely understandable.

Table 8 also indicates that the calcification of the tooth and the growth of the alveolus and periodontal tissues are not identically synchronized in all individuals, and this finding substantiates the conclusions of Brauer and Bahador. *These variations suggest that on any individual basis, the calcification of a tooth may be a more meaningful indication of somatic maturation than is its*

TABLE 8

Degree of root formation at the time of alveolar emergence and first recorded appearance of tooth in oral cavity

ROOT STAGE	ALVEOLAR EMERGENCE		FIRST PRESENCE NOTED IN ORAL CAVITY	
	No. boys	No. girls	No. boys	No. girls
Total series	21	21	21	17
Beginning of root to 1/4 complete	10	8	0	1
1/4 complete	7	10	5	1
1/4 to 1/3 complete	0	0	1	1
1/3 complete	3	3	2	4
1/3 to 1/2 complete	0	0	0	1
1/2 complete	1	0	9	6
1/2 to 2/3 complete	0	0	1	0
2/3 complete	0	0	2	0
3/4 complete	0	0	0	3
3/4 to almost complete	0	0	1	0

(From original of table 8, Gleiser and Hunt: *Am. J. Phys. Anthrop.*, N.S. 13: 269, 1955.)

clinical emergence. A further advantage of studying calcification is that it can be assessed at any time during the span of active growth of the tooth; whereas clinical emergence is a fleeting event whose exact time of occurrence it is often impossible to determine.

Complete histories of carious breakdown for each deciduous and permanent tooth have been charted at the Forsyth Dental Infirmary for Children for the members of the present series. From this information, the ages were determined, wherever possible, at which occlusal and proximal carious lesions were first observed in this tooth. These two sites were chosen to represent both of the chief classes of carious lesions in young individuals: pit and groove lesions (occlusally) and smooth surface lesions in proximal sites.

The mean ages were determined at which the first occlusal and proximal lesions were found in boys and girls but, since radiographic shadows of calcifying teeth do not permit an unambiguous separation of growth rates for enamel, dentine, and cementum, it is not possible to relate the present findings to the specific growth spans of any one of these tissues. Instead, the timing of detectable carious involvement is related to the calcification of the whole tooth.

Although the actual sex difference in occlusal lesions is 6.4 months, these lesions appear so soon after clinical emergence in most Boston children that their onset in both sexes does not diverge markedly from the hypothesis of Mellanby and Hurme.

The proximal lesions, however, show a considerably earlier average age of first detection in girls than can be explained from the timing of calcification or emergence alone.

The characteristic finding in tracing "bone age" and "dental age" serially on the same child is that severe and prolonged delays in osseous maturation, as shown when the "least mature centers" fail to progress in their calcification in the hand, can also be seen in the tooth. In general, however, the delays in dental calcification are less prolonged than those of the wrist and hand.

In the present series of Boston children, the cleft between the roots of the permanent mandibular first molar begins to calcify soon after the first appearance of mesial and distal spicules of the newly forming roots. At this time, the tooth is beginning its movements of eruption. The rapid development of the cleft might lead one to suspect that it acts as a wedge in propelling the tooth during eruption.

On the other hand, the cleft does not calcify at the onset of eruptive movements in all human molars. A conspicuous delay in this calcification occurs in taurodontism, in which a large pulp chamber occurs in combination with short, partly fused roots.

A few girls, but none of the boys, showed early onset of calcification. At 3 months an insignificantly greater average number of calcified cusp centers occurred in the boys.

The onset of coalescence of the cusp centers, on the average, is visible at 7 months in both sexes. At later stages of calcification, however, a slight linear increase in the precocity of female development was observed. The average span of active growth of this tooth in females is 96 per cent of the male span, and the female tooth is also smaller by an equivalent amount in its linear dimensions. The absolute velocities of elongation of this tooth in the two sexes are therefore similar.

The growth in height of the crown accelerates until this structure is completed. The initial elongation of the roots is slow but, between the stages

when one-third to one-half of the roots are calcified, their growth is rapid. Later, root growth decelerates for an unknown period of years.

When the preceding rates of elongation are related to eruption, it is found that the initial slow growth of the roots coincides with the tilting of the occlusal-apical axis of the tooth toward its mature vertical inclination. Root growth is only slightly more rapid during the interval from alveolar emergence to clinical emergence. From clinical emergence until the tooth approaches the occlusal plane, the speed of elongation of the roots is maximal. The final one-quarter of root growths is slower, but this elongation is greater than the occlusal-gingival eruption of the tooth as measured from casts. This difference may reflect downward growth of the roots toward the mandibular canal, upward growth of the periodontal tissues or, more likely, both patterns.

Variability in root development is moderate at the time of alveolar emergence but far greater at the time when the tooth is first clinically observed in the oral cavity. Calcification and eruption are not identically synchronized in all children but, on the average, clinical emergence occurs soon after one-third of the root is completed.

On an individual basis, the calcification of a tooth may be a more meaningful indication of somatic maturation than is its clinical emergence. Another important advantage of calcification is that it can be evaluated at any time during the span of active growth of the tooth.

In Boston children, occlusal lesions appear so soon after the time of emergence that the sex difference in the mean age of detection of the first occlusal lesion closely resembles the contemporaneous sex differences in calcification and emergence. But proximal lesions show a precocity of first detection in girls which is far greater than the development precocity of the female tooth. The biochemical mechanism underlying this vulnerability of proximal sites in girls is unknown.

Comparisons between dental and osseous calcification in the same child can be made by tracing the ages at which the various stages of dental calcification occur as an additional line on a "Red Graph" of osseous maturation of the hand. Such individual graphs show that developmental arrests in bone growth often coincide with arrests in the tooth. In general, however, delays in dental calcification are less severe or prolonged than are those of the wrist or hand. Since delays in calcification affect both the bones and the teeth, it is possible to use dental radiographs for the assessment of growth progress in children.

In all three permanent mandibular molars, the distobuccal (hypoconid) and distal (hypoconulid) cusp are relatively variable in size. These cusps are especially important in the mechanics of molar reduction in man. The ontogenetic and phylogenetic instability of these lobes in the molar crown may prove to be interrelated.

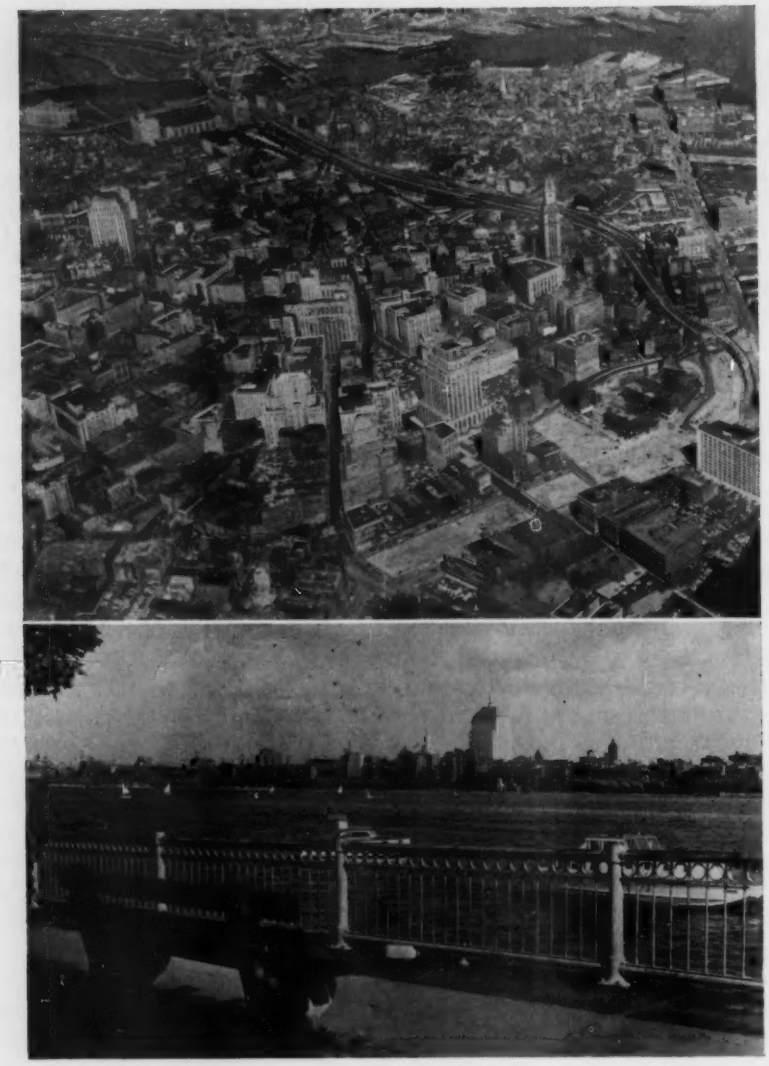
The rapid growth of the cleft between the roots in most human molars occurs at the onset of the movements of eruption. Perhaps the growing cleft acts as a wedge in moving the tooth.

News and Notes

American Association of Orthodontists
Past Presidents' Luncheon

The annual luncheon for the past presidents of the American Association of Orthodontists will be held at 12:30 P.M., May 1, 1956, at the Hotel Statler, Boston, Massachusetts, during the meeting of the A.A.O.

A.



B.

Two views of present-day Boston, where the fifty-second annual meeting of the American Association of Orthodontists will be held April 29 through May 3, 1956.

A, Aerial view of the City of Boston.

B, Boston as seen from the banks of the Charles River in nearby Cambridge.

Rules Governing Visitors to the 1956 Meeting of the American Association of Orthodontists April 29 through May 3, 1956, Hotel Statler, Boston, Mass.

To insure full participation of all members, it is necessary to limit attendance to fully privileged members of the American Association of Orthodontists and the following:

A. *No attendance fee.*

1. Full-time teachers in university dental schools.
2. Full-time graduate or postgraduate students in university orthodontic departments.
3. Dentists from outside Canada or the United States of America who are members of recognized dental or orthodontic organizations.

B. *Attendance fee $10.00.*

1. Associate or junior members of constituent societies of the American Association of Orthodontists.
2. Recent graduates of university orthodontic departments who are in service.

C. *Attendance fee $20.00.*

1. Recent graduates of university orthodontic departments who are not members of constituent societies of the American Association of Orthodontists.
2. Other guests certified by the Credentials Committee.

Those desiring to attend the meeting who qualify under the catagories listed above should contact the chairman of the Credentials Committee for approval of their credentials.

Credentials Committee,
RAYMOND M. CURTNER
FREDERICK B. LEHMAN
ABIJAH PIERCE, Chairman
58 Federal St., Greenfield, Massachusetts.

Eastman Dental Dispensary

The Eastman Dental Dispensary in Rochester, New York, announces a postgraduate course in orthodontics. The course, beginning in September, will be eighteen months to two years in duration. Candidates for an advanced degree in dentistry must enroll in the two-year program; supplementary course work will be offered at the University of Rochester, School of Medicine and Dentistry.

Five graduate dentists will be accepted each September. Applications will be received up to June 1.

Further information and application forms may be obtained from Basil G. Bibby, Director, Eastman Dental Dispensary, Rochester 3, New York.

University of Pennsylvania

The University of Pennsylvania announces a postgraduate course entitled "The Twin Wire Mechanism." The course, taught by Dr. Joseph E. Johnson, will be given June 4 to 8, 1956. It is an advanced course for dentists who are engaged in the practice of orthodontics. All applicants should be members of sectional societies of the American Association of Orthodontists or hold certificates from a recognized graduate course in orthodontics.

First Dental Education Workshop

The First Dental Education Workshop will be held at the Hotel Statler, New York City, on Friday, April 20, 1956. The theme of the one-day conference is "Professional Education of Dentists for Tomorrow."

The Workshop is held in connection with the program of the First District Dental Society of New York, Alfred J. Asgis, Director.

American Institute of Dental Medicine

The next annual meeting of the American Institute of Dental Medicine will take place at El Mirador, Palm Springs, California, Nov. 4 to 8, 1956. The essayists will be Drs. Francis L. Chamberlain, Milton B. Engel, Donald A. Kerr, Helmut A. Zander, and S. I. Hayakawa.

Applications and full information may be secured from the executive secretary, Miss Marion G. Lewis, 2240 Channing Way, Berkeley 4, California.

Italian Society of Stomatology

The meeting of the Italian Society of Stomatology will take place in Florence, Italy, Sept. 24 to 29, 1956. Papers will be presented on the following subjects:

Up-to-Date Views on Oral Liquids. Prof. R. Bandettini.

Precocious Diagnosis and Therapy in Dental and Facial Orthopedics (Subject of the Social Dentistry). Prof. A. Maggioni.

Materials and Techniques for Taking Impressions. Prof. G. Pejrone.

For further information, write to the Congress Secretariate, 25 Via San Gallo, Florence, Italy.

American Association for Cleft Palate Rehabilitation

The fourteenth annual meeting of the American Association for Cleft Palate Rehabilitation will be held at the Muehlebach Hotel, Kansas City, Missouri, May 3, 4, and 5, 1956.

Mexican Orthodontic Society

The following officers have been elected by the Mexican Orthodontic Society:

President, Samuel Fastlicht.
Secretary, Roberto Vivanco.
Treasurer, Margarita Correa.

Notes of Interest

Ralph E. Braden, D.D.S., orthodontist, announces the removal of his office to Plaza Office Bldg., 3387 Poplar Ave., Memphis, Tennessee.

Robert J. Butz, D.D.S., M.S.D., announces the opening of his office at 820 West Eleventh St., Hastings, Nebraska, practice limited to orthodontics.

Harold M. Clapp, D.D.S., announces that Herbert L. Ruff, D.D.S., will hereafter be associated with him in the practice of orthodontics at 1600 Genesee St., Utica, New York.

Russell E. Irish, D.D.S., Pittsburgh, Pennsylvania, announces that Andrew T. Pauchura, D.D.S., is now associated with him in the practice of orthodontics at 5039 Jenkins Arcade.

Joseph M. Rivera, D.D.S., is now located at 1250 Big Bend Blvd., St. Louis, Missouri, practice limited to orthodontics.

Dr. Alexander Sved announces the removal of his offices to Steinway Bldg., 113 West 57th St., New York 19, New York, practice limited to orthodontics.

Faustin N. Weber, D.D.S., orthodontist, announces the removal of his office to Plaza Office Bldg., 3387 Poplar Ave., Memphis, Tennessee.

OFFICERS OF ORTHODONTIC SOCIETIES

THE AMERICAN JOURNAL OF ORTHODONTICS is the official publication of the American Association of Orthodontists and the following component societies. The editorial board of the AMERICAN JOURNAL OF ORTHODONTICS is composed of a representative of each one of the component societies of the American Association of Orthodontists.

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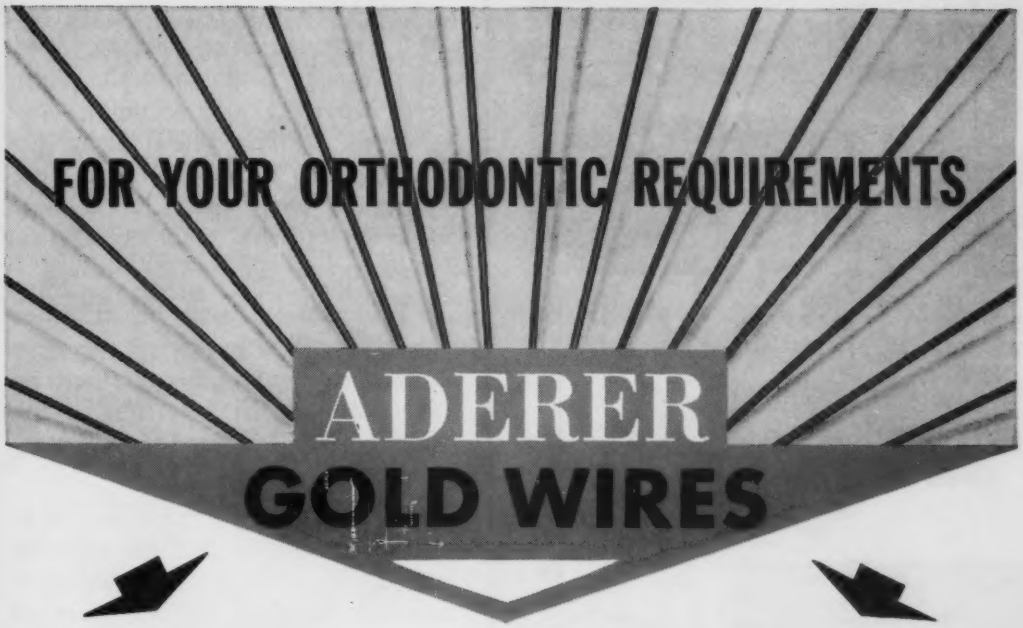

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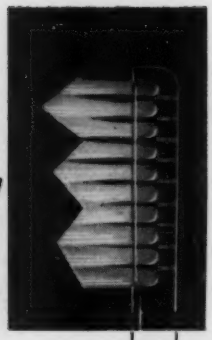

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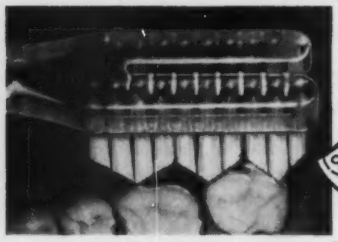

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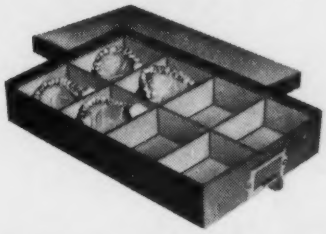

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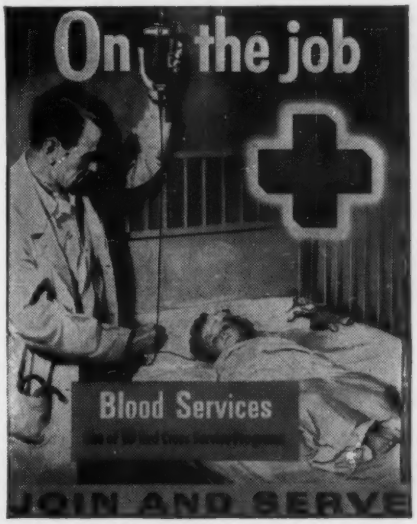

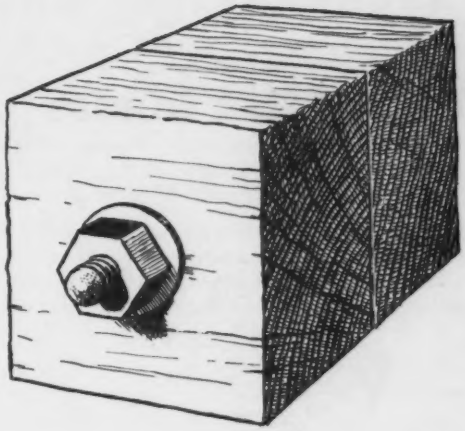

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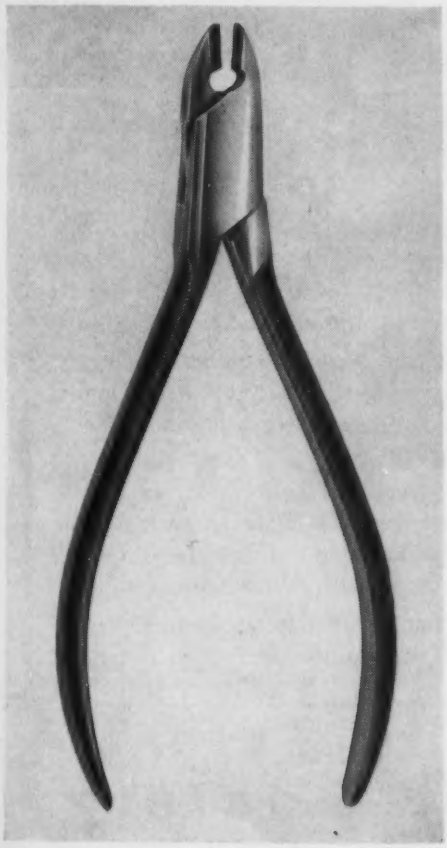

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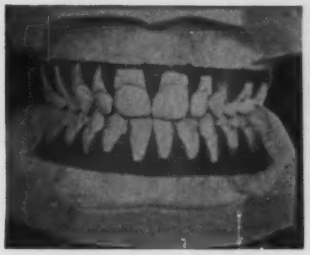

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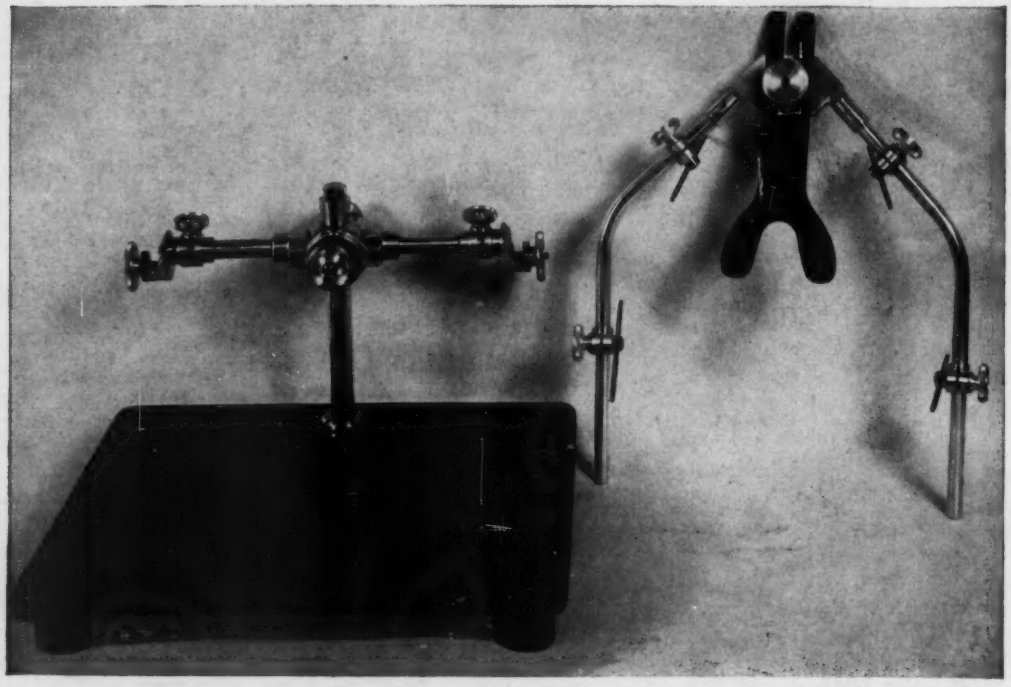

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